Smoke pours from a burning Sherman tank of the Third Armored Division, knocked out near Bergerhausen, Germany, on the road to Cologne, 1945. Source: US Army Photo

Faint Praise

American Tanks and Tank Destroyers during World War II

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Introduction

> A Bronx Cheer comes out of Germany to greet the news that the Pershing tank has gone into mass production. It is the opinion of the men at the front, apparently, that they will get the new tank in numbers when it is no longer needed, i.e. when the war is over . . . an investigation is thoroughly in order. It should take up the reasons for the long delay in getting the Pershing in production. It should likewise find out why our tanks are inferior to the enemy's.[1]

This comment from the *Washington Post* is typical of press criticism of American tanks, most notably the M4 Sherman during the first months of 1945. The Battle of the Bulge, bitterly fought during December 1944 and January 1945, had exposed serious deficiencies in the ability of American tanks to combat the heavier German Panzers. Correspondents heard the angry voices of the GIs, and berated the War Department for its failure to provide the Pershing (or M26) sooner. Charges of inferior American tanks and rebuttals by US Army leaders remained in the news until Allied armies crossed the Rhine at the end of March. The slogging winter battles to the Rhine, which had shown American tanks at their worst, were followed by swift advances through Germany, which displayed those same tanks at their best. Public interest in the quality of tanks rapidly waned, and the investigation demanded by the *Washington Post* never occurred.[2]

Perhaps the first word of what would become the prevailing historical interpretation of American tank development came from Col. Joseph M. Colby, Wartime Developments Director of the Tank-Automotive Command. In 1945 he wrote that the theme "We'll win the war with the M4" had hampered tank development.

Five years later he elaborated his ideas in an article which condemned the War Department for not ordering production of several tanks developed by the Ordnance Department, and which were superior to the Sherman in Colby's opinion.[3] This latter article also provides an early example of the factual errors which characterize the prevailing view of American tank development. The T20E3 was one of the tanks that the War Department refused to manufacture, although Colby asserts that the tank was released for production in 1942. In fact, Ordnance Department records indicate that the T20E3 was not ready for production in 1942. Further, Colby himself telephoned his superior, Maj. Gen. Gladeon M. Barnes, Chief of Research and Development for the Ordnance Department, on 15 August 1943 to recommend dropping the T20E3 in favor of another tank because, as he put it, "They can't keep transmissions running in the T20E3."[4]

The thesis that the Ordnance Department was not to blame for the deficiencies of American tanks gained the support of official scholarship, represented by the three histories of the Ordnance Department in World War II. The authors of these books agree that the Armored Force and Army Ground Forces (AGF) slowed tank development by failing to approve the designs and proposals of the Ordnance Department. AGF and its commander, Maj. Gen. Lesley J. McNair, take most of the blame. This view has become the standard interpretation of the problem. For example, Russel F. Weigley reproduces the position of the Ordnance Department in his widely respected *History of the United States Army*.[5]

However, this view does a disservice both to history and Lesley J. McNair. The latter was one of the most innovative thinkers in the history of the US Army; he never deserved to be characterized as a curmudgeon throwing obstacles in the path of progress. More importantly, the problems of American tank development were far more complicated than the bureaucratic battle between three US Army agencies which the official histories depict. The difficulties involved doctrine, personality, military intelligence, and technology. This study will attempt to explain how all of these factors affected American tank development during World War II.

One of the reasons why the US Army continued to fight with the Sherman tank was simply because the units in combat were satisfied with that tank until late in the war. Their complacency was undisturbed by combat experience. Technical intelligence, a func-

tion of the Ordnance Department, failed to reveal the technological threat posed by the increasingly numerous, heavy German tanks that would face American soldiers in 1944. The official historians pay little attention to the impact that opinions from the combat zones made on tank development, particularly during 1942 and 1943 when there was still time for major changes. There was no great demand from overseas for a better tank than the Sherman until the last months of the war in Europe.

This fact highlights perhaps the single most important factor concerning tank development—time. It takes years to design and then produce any major item of miltary hardware. When the leaders of the US Army realized during the summer of 1944 that the capabilities of German tanks posed a significant tactical problem, it was far too late for a new technological solution. Only equipment already under development or in production would be available in time to be of any use.

Time, though, was the relentless arbiter of technological development everywhere. In the United States, the Army's unique doctrine was also a major factor. Sherman tanks were later condemned for their inability to destroy German tanks, but they were not designed or intended to accomplish that task as a primary mission. Rather, the task of anti-tank warfare in the US Army belonged to the tank destroyers, and their development was intertwined with that of tanks. When a need appeared for better anti-tank guns, US Army doctrine, represented by AGF, called for these weapons to be mounted primarily in tank destroyers. Tank destruction was only a secondary requirement for tank guns. The US Army did not expect its tanks to get into slugging matches with other tanks. According to Army doctrine, "the most profitable role of the armored division is exploitation."[6] The role of exploitation was reflected both in the organization of the first American armored divisions and in the design and types of tanks within those divisions.

Mobility, according to pre-war theory, was the primary requirement for exploiting tanks. The two main factors of mobility were speed and low weight. Speed was obviously desirable and, given the horsepower available in engines of the 1930s, low weight was necessary to achieve high speed. In addition, low weight made tanks less vulnerable to obstacles such as small bridges. The original organization of American armored divisions reflected such thinking. These units had two light tank regiments and only one medium tank

regiment. The more heavily armed and armored medium tanks were intended to support the light tanks and tackle objectives too difficult for the latter. This concept was also reflected in the organization of the British Army, which equipped its early armored divisions with fast "cruiser" tanks and the Mark IIIs of the German Panzer divisions early in the war.[7] However, as a result of combat experience during World War II, light tanks lost this preeminent place in the armies of the world. Light tanks, inherently lightly armored, simply could not survive against increasingly effective and numerous anti-tank guns as the war progressed. The German and British light tanks were discarded during the war, and the US Army relegated its eight tanks to reconnaissance duties.

The weapons of these early tanks also reflected pre-war thinking, which would change drastically during the war. The main tank weapon prior to World War II was the machine gun. The large caliber, dual-purpose gun was a result of combat necessity and not pre-war theory. Virtually all armies recognized that tanks needed to confront enemy armor, and this requirement was satisfied by equipping tanks with small caliber anti-tank guns. Yet these were of not much use for anything other than penetrating armor. The American light tank and the only medium tank available in 1939 carried the same 37-mm gun. Similarly, the German Mark III carried a 37-mm gun until 1941, but it was supported by the Mark IV which carried a 75-mm howitzer for high-explosive fire. The clearest examples are the British cruiser and infantry tanks which had only solid shot for their 40 mm guns. These small guns became obsolete during the war as armies began building tanks with thicker armor. The simplest and most successful reply to thicker steel proved to be larger caliber weapons with muzzle velocities comparable to anti-tank guns. Typically, anti-aircraft artillery was adapted to tanks. The larger projectiles of the bigger guns provided an effective capacity of high-explosive fire in addition to superior armor-penetration ability. These were altogether more useful weapons than the small guns of the pre-war period. After World War II, the large, dual-purpose gun became the basic tank weapon in all armies. The light and medium tanks that the US Army had available in 1940 and 1941, based on pre-war thinking, were finally measured against post-war knowledge.

The tanks available to the US Army at the start of World War II also reflected the lack of funds available to the Ordnance Department during the Depression. Limited money forced the Ordnance

engineers to focus on developing components rather than complete designs.[8] Many of these same components, such as volute spring suspensions, rubber block tracks, and radial aircraft engines, were features of all American tanks early in the war. Both medium and light tanks used almost identical components, despite the fact that the Cavalry controlled the design of light tanks—dubbed "combat cars" to avoid problems with Congress—while Infantry controlled medium tanks. This situation was not corrected until the creation of the Armored Force in July 1940.

The American light tank was the M3 Stuart, a culmination of inter-war development. It carried five machine guns and a 37-mm gun. Its speed, maneuverability, and mechanical robustness earned it the sobriquet "Honey" from the British soldiers who received them in North Africa. With better armor, engine, and transmission, the tank was redesignated the M5 and remained the principal light tank of the US and British armies until the end of World War II, despite the many weaknesses that appeared with combat experience.

The medium tank available in 1939, the M2, was a mobile machine gun nest consisting of eight machine guns and a 37-mm gun. It used many of the same components as the M3 light tank and reflected the fact that the Chief of Infantry controlled its design. Germany's use of 75-mm weapons on its tanks early in the war convinced both the Ordnance Department and the Chief of Infantry in 1940 that something would have to be done with the M2. The advantages of mounting a 75-mm gun in a turret were obvious but threatened to take too much time. In the interim, designers managed to mount the 75-mm gun in a more heavily armored M2. The result was the Grant or M3 (or Lee in its British configuration) which entered combat at Gazala in 1942, earning Rommel's respect. Although its replacement, the M4 Sherman, was already in production, the M3 served as the medium tank of the American armored divisions which took part in the North African invasion in November 1942.[9]

Thus, as the US Army refined its doctrine during 1941, American soldiers possessed a fast, reliable light tank to execute slashing advances in the enemy's rear, supported by an equally reliable medium tank which, for its day, was heavily armed. But the US Army had not arrived easily at its doctrine.

There had been a long debate during the inter-war years within the industrial nations about the proper use of armor. Various theo-

ries had been presented, but it became clear during the first year of the war that the argument had been settled. Germany's doctrine of massed armor had led to the defeat of Poland in only six weeks. Then, impressive as it was, the conquest of Poland was completely overshadowed by the cataclysm in Flanders the following spring. In barely a month's time, German armor crushed the most respected army of pre-war Europe. The German success stopped the argument over how to best employ tanks, but created another doctrinal problem. Before the US Army could accomplish its offensive intentions, it first had to stop the awesome Panzer divisions.

Shocked from complacency, US Army leaders began sifting through the accounts of what had happened in France. With limited information, they tried to discover the true nature of the beast and devise some way of coping with it. Brig. Gen. Henry L. Twaddle, whose job as the War Department's G–3 made him staff officer responsible for US Army training and organization, underlined the gravity of the situation by saying, "Stopping enemy tanks and other mechanized vehicles is the biggest job confronting our Army today."[10]

Lacking a successful European model, the US Army devised its own system for anti-tank warfare—tank destroyers. The American concept, which committed most of its anti-tank assets to semi-independent battalions assigned to a central force pool, was not duplicated in any other army. Essentially, other armies merely increased their anti-tank firepower through bigger, better, and more numerous anti-tank guns. The anti-tank formations of other nations reinforced divisions or were organic within them. Divisions, then, continued to fight the anti-tank battle. In contrast, the United States developed a doctrine specifically designed to counter tanks and created special units to implement the doctrine. American doctrine visualized fighting tanks behind the divisions with specialized units under corps or army control.

Like the tank destroyer battalions, American Gun Motor Carriages, which were popularly called tank destroyers or "TDs," were unique to the US Army. Designed to implement a specific doctrine, the fast, turreted, lightly armored tank destroyers of the United States had no foreign counterparts. Instead, the European armies provided mobility and armor protection for increasingly heavy anti-tank guns in other ways. The British tried mounting anti-tank guns on trucks. The Germans favored the modification of existing, often

obsolete, tank chassis to carry the largest gun possible, and Russian efforts mimicked the German. The visible differences between the tank destroyers and the German or Russian self-propelled guns reflected opposing tactical views. The wartime development of American specialized vehicles proved to be more difficult than the German or Russian ventures, which were straightforward adaptations that sacrificed gun traverse for bigger guns. Developing the desired fighting vehicles proved to be the biggest obstacle involved in creating the tank destroyers. Development of new equipment took time; meanwhile, the tank destroyers had to enter battle with makeshift equipment, hastily built during the first years of US Army expansion.

The test of combat affected both doctrine and equipment. The limitations of the first tank destroyers forced the adoption of equipment unsuited to tank destroyer doctrine—towed anti-tank guns. This led to a new path of development, and doctrine had to be reformed to accommodate the new weapon.

In addition, the tank destroyers rarely faced the enemy that they were designed to meet, massive armored attacks. The big German tank formations were severely depleted in Russia. Meanwhile, the Germans began piling heavier armor on their tanks. Technical intelligence failed to expose the danger of this new threat, although the tank destroyers were forced to adopt far heavier weapons than those envisaged in 1941 in order to combat the heavy German armor.

Perhaps just as important to the fate of the tank destroyers was the fact that their basic doctrine was never fully accepted throughout the US Army. Many officers were simply unaware of the doctrine. Promulgating a radical new doctrine throughout a large army is very time consuming, probably more so than developing equipment. This was particularly difficult in a rapidly expanding army which was hard-pressed to teach basic tactics to thousands of officers only recently involved in civilian pursuits. Moreover, many influential officers disagreed with the doctrine. The decision from the top to create tank destroyers had not convinced many important generals that it was the right thing to do, and Gen. George C. Marshall, Chief of Staff, could not force those generals to use the doctrine in combat. The best method for stopping enemy tanks was debatable before Marshall's decision, and it remained so afterwards.

There were essentially two conflicting positions. One held that

the best defense against tanks was to improve the effectiveness of specialized anti-tank measures, for which tank destroyers were the chosen method. The opposing idea was that enemy tanks should be stopped by friendly armored formations.

In July 1940 Maj. Gen. George A. Lynch, Chief of Infantry, advised the G–3 of the War Department to adopt the latter proposition. Gen. Lynch argued that anti-tank guns, due to their vulnerability while moving, could only be used to oppose the initial attack of armored forces; they became useless if the enemy force achieved a breakthrough. He concluded that "the best anti-tank defense lies in the defeat of hostile armored forces by our own armored units." According to Lynch, the French had failed because they lacked effective mobile units: "anti-tank guns proved inadequate to meet a breakthrough, even against the most lightly armored tanks."[11]

Gen. Lynch's proposal was rebutted by none other than Gen. Lesley J. McNair, then Chief of Staff of the General Headquarters (GHQ) and one of the most influential men in the US Army. Born in Minnesota in 1883, McNair had attended the United States Military Academy, graduating in 1904. He became one of the youngest generals in the Army during World War I after Gen. John J. Pershing selected him to head the AGF's artillery training. McNair had been responsible for testing the new triangular division in the 1930s, and Marshall's selection of him as Commandant of the Command and General Staff School was a further recognition of his intellectual reputation. His job in the GHQ ultimately evolved into command of AGF and responsibility of organizing and training the largest land army ever created by the United States.

McNair was an intellectual of firm convictions. A mathematician, he was never far from his slide rule. His reputation for aloofness was undeserved according to his friends. It stemmed largely from his deafness, a common artillery affliction, as well as McNair's avoidance of the Pentagon. He refused office space there for AGF, which remained at the War College. His firmness of conviction is perhaps best illustrated by his ruthless efforts to trim excess men and equipment from US Army organizations, despite bitter opposition from overseas. He made his own inspection trip to Tunisia in 1943 and remained unawed by combat commanders, commenting that "[their] offhand and fragmentary views are not infallible."[12]

Gen. McNair's response to the Chief of Infantry's memo clearly

explained his ideas concerning anti-tank defense. "It is believed," commented McNair, "that the European war to date has supplied no conclusive lessons as to anti-tank defense, other than that it has been inadequate." McNair pointed out that during tests of the triangular division in 1937, anti-tank units proved to have mobility equal to armor units. He contended that:

> Anti-tank guns must be organized and "multiplied" so as to permit their timely concentration in numbers commensurate with the strength of the hostile tank attack. Their organic assignment to divisions and similar units tends to prevent their concentration when and where needed, and subjects us to the inevitable consequences of dispersion. An anti-tank gun is cheaper than a tank. Providing anti-tank guns in fully adequate numbers is a waste of resources only in case such guns are dispersed so widely as to be effective nowhere. . . . [Anti-tank] guns should be organized in tactically self-sufficient battalions, each complete with warning communications . . . this number of guns should constitute a mobile GHQ reserve, available for meeting major masses of tanks.[13]

McNair's comments outlined the concepts which ultimately led to tank destroyers. He fought the dispersion of anti-tank guns, although he was willing to accept some scattering of those weapons. He noted that "guns should be provided organically in the infantry division, in order that it never may feel helpless against tanks."[14]

Gen. McNair opposed tank v. tank combat because such action wasted tanks. He pointed out that "[the tank's] natural and proper victim is unprotected personnel and matériel." To Gen. McNair, a tank v. tank battle would be "one in which both sides are certain to sustain heavy losses in costly matériel—which could be employed more profitably and effectively against more vulnerable targets."[15]

The ideas of mass and mobility were essential to McNair's ideas for anti-tank warfare. He maintained that "the great mass of anti-tank and mobile anti-aircraft guns should be held in large masses. This mass should shift along the front directly opposite the mass of enemy mechanization."[16] By taking its orientation from the enemy's tank forces, McNair believed that this mass could always be superior to the enemy force in any particular locale.

That McNair did not advocate any specific organization or

weapons is significant. He believed that such details should be determined by field tests. By stating only general concepts, McNair was never maneuvered into defending a doctrine that had not been fully developed. He retained his flexibility and avoided interfering with details, organization, or weapons, although he might disagree on specific issues.

McNair's influence is apparent from a message that Marshall sent to the War Department G–3 on 14 May 1941:

> I am certain that one of our urgent needs is for development, organization and immediate action on the subject of defense against armored forces to include an offensive weapon and organization to combat these forces.[17]

He went on to comment that such a force should use rapid movement to intercept enemy forces and fight them with active defensive tactics. Marshall normally would have delegated the creation of such a force to one of the combat arms, but he felt that the complexity of combined arms within such units would put them beyond the scope of any single arm. Therefore, Marshall directed the G–3 to take action on the matter and flatly stated that he did not want to bring up the question of a new combat arm. He had decided in favor of McNair's views. A new organization, ultimately christened tank destroyer, not our own armored divisions, would form the main defense against enemy tanks.

Marshall's important decision was based on limited information. Detailed military information reached the United States slowly, and it was usually fragmentary, often erroneous. For example, Gen. Lynch's statement about the inadequacy of anti-tank guns was not supported by the facts. French 25-mm and 47-mm anti-tank guns could penetrate German light tanks, though he apparently did not know this. McNair's remark about the lack of "conclusive lessons" was an admission of incomplete knowledge. The persistent myth that the Germans had used 70-ton "breakthrough" tanks is another striking example of misinformation. In fact, the Germans possessed no such tanks in 1940. But this myth was still current when Marshall made his decision.[18] Marshall probably realized that the available information was incomplete, but he could not wait for muddy waters to clear. Other theaters, where tanks were unimportant, demanded his attention, and it was an undeniable fact that German tanks had played a major role in the French debacle of 1940.

German armor was too dangerous to ignore, and there was no time to wait for slowly accumulating facts to be studied exhaustively. Thus Marshall asked his G–3 for an antidote to massed tanks, but he could not offer much time for development. Many commanders would disagree with the Marshall solution, and again there would be no time to educate them. Combat experience would also be inconclusive, for fate decreed that the US Army would not face massed tanks until the Battle of the Bulge in 1944. By then the Germans had developed heavy dueling tanks by an evolutionary process which was simpler than perfecting two arms—tanks and tank destroyers—separately.

The development of American tank destroyers continued concurrently with that of tanks, and the two development efforts affected each other. Ultimately, tank destroyers became quite similar to tanks. As the differences between these two weapons decreased, the tank destroyer came to be viewed as a less efficient, hybrid tank. The type was abandoned after World War II, when tanks were finally deemed the best anti-tank weapon. But it took the combined lessons of technological development and combat experience to bring the US Army to the latter viewpoint. During the war, tank destroyers were part and parcel of the controversy over tank development.

1

Army Anti-Tank Doctrine and Army Organization for Research and Development

When Gen. Marshall decided to create an offensive organization to combat tanks, he had only a general concept. The formation of the tank destroyer units would involve not only an entirely new organization, but new doctrine and equipment as well, all created from scratch. Development would also have to take into account the lessons of on-going combat, which had to be absorbed from the limited information available to a neutral nation.

In the same memorandum which directed the creation of the new tactical formation, Marshall also directed the formation of a new staff element in the War Department. He ordered Twaddle to

> organize in your division a small planning and exploring organization, composed of visionary officers, with nothing else to do but think out improvements in methods of warfare, study developments abroad and tackle such unsolved problems as measures against armored force action . . .[1]

The G–3 established the Planning Branch the following day. A relatively unknown Lt. Col. of Infantry, Andrew D. Bruce, was named to head the new organization. His most important duty was to explore ideas for the organization and doctrine of the new anti-tank units.

During the summer of 1941, two events occurred that encouraged American endeavors toward anti-tank defense. First, the Germans destroyed over 200 British tanks in a single battle in North Africa. This was the first engagement that Americans knew of in which a large number of tanks had been decisively stopped. The first defeat of a large force of tanks was good news in the United States, even though the prospective foe had been the victor. In addition, the maneuvers of the Second Army in Tennessee had demonstrated that

the location of large enemy tank units could be tracked continually, permitting friendly anti-tank units to be moved and massed to counter them.[2]

Soon after the Second Army maneuvers, the War Department G-3 assembled an important anti-tank conference. The prestigious assembly at the US Army War College included representatives of the War Department and GHQ; anti-tank officers from armies, corps, divisions, and service schools; and the Chiefs of Engineers, Artillery, and Infantry. The significance of the conference was twofold. First, it showed that the most influential figures in the Army's bureaucratic hierarchy had lined up to support the Chief of Staff's position. The participants were able to agree on the concept of a mobile, semi-independent tank-destruction force. The only serious note of disagreement at the conference was the statement from Maj. Gen. Courtney Hodges, Chief of Infantry, that the infantry should not be left unprotected against tanks.[3] Arrival at this bureaucratic consensus on the controversial topic of anti-tank warfare was a milestone. Second, the Conference revealed that the basic operational concepts and general organization of the new anti-tank organization had already been developed.

But the consensus was misleading. It meant only that the US Army's hierarchy would not oppose the creation of such a force. Success for the new units would depend on the willingness of major commanders to use the new formations properly in combat. With the exception of Hodges, the only dissenting voice, the men at the conference were not those who would go on to command large units against the Germans.

The outline of the tank destroyer force was already well defined at the time of the conference. Gen. Twaddle, the G–3, divided the problem of building a tank destroyer force into two phases: first, determining how to use equipment that was readily available and how to organize it properly; second, developing weapons, organizations, and tactics to stay ahead of any foreign developments. The proposed anti-tank unit that was explained at the conference included a headquarters battery, a reconnaissance battery, and three anti-tank batteries.[4] Perhaps the most substantial change in the subsequent organization was the use of the term "company" instead of "battery." The latter was strictly an artillery term and probably seemed too parochial.

Gen. McNair, who made the closing remarks at the conference, emphasized the aggressive nature of the new units:

> The counter-attack long has been termed the soul of defense. Decisive action against a tank attack calls for a counter-attack in the same general manner as against the older forms of attack. A counter-attack of course may be delivered by other tanks, but the procedure is costly. There is no reason why anti-tank guns, supported by infantry, cannot attack tanks just as infantry, supported by artillery, has attacked infantry in the past. Certainly it is poor economy to use a $35,000 medium tank to destroy another tank when the job can be done by a gun costing a fraction as much. Thus the friendly armored force is freed to attack a more proper target, the opposing force as a whole, in much the same manner as seacoast defenses free the Navy for defensive action at sea.[5]

Following the July conference, US Army planners made rapid progress with the tank destroyer concept. McNair ordered the Second and Third Armies to form provisional battalions for use in maneuvers. He ordered the Third Army to form groups of three battalions, each under a single group headquarters in an effort to centralize anti-tank operations even further. The GHQ and men working on the new anti-tank doctrine viewed the employment of the new units as a success during the maneuver in the fall of 1941, although there was a tendency to disperse the elements too quickly and thus dissipate their strength.[6]

In view of the success of the provisional anti-tank units, Gen. Twaddle developed long-range plans for such units. The G-3 recommended four anti-tank battalions per division for the 55 divisions he envisioned. Of these 220 battalions, 55 were to be organic to the divisions; 55 were allocated to armies or corps; and the remaining 110 were reserved for the GHQ.[7] The large number of anti-tank battalions (220) indicates the seriousness with which the War Department viewed the armored threat.

Twaddle also recommended that the three established arms with an interest in anti-tank warfare—Infantry, Cavalry, and Field Artillery—should each be given the responsibility to form anti-tank battalions for their own units. Further, Twaddle proposed that the Armored Force, which had earlier indicated no desire to accept responsibility for anti-tank units, should establish an anti-tank center.[8] This would have hopelessly confused the effort to create the new units. Each branch would have devised its own tactics and

organization, generating a demand for different equipment, and the Armored Force, fully committed to its own projects, would have had to settle the resulting disputes.

Marshall's response was a victory for McNair and his desire to centralize anti-tank units. The established branches would assume no responsibility for the new units. Instead, the War Department would control the anti-tank center. No battalions would be allocated to divisions, and all of the fifty-five battalions ordered for immediate activation were to be under the control of GHQ.[9]

The establishment of an anti-tank center was not intended to create a new arm. Instead, the center was to be similar to the machine gun centers established during World War I, offering a central place for training units with a new type of weapon and new tactics, since such expertise was lacking in the US Army as a whole. The units trained by the center would then be alloted to existing organizations.[10]

On 27 November 1941, the War Department ordered the activation of the Tank Destroyer Tactical and Firing Center. This day, if any, can be called the official birthday of tank destroyers. Col. Bruce was named to command the new center, which was to be located at Fort Meade, Maryland, until a permanent site could be selected.[11]

The directive of 27 November also gave a new name to anti-tank units. The term "tank destroyer" had been used on various occasions for months, but "anti-tank" had remained the official term. Effective on 3 December 1941, the War Department ordered all anti-tank battalions to be redesignated "Tank Destroyer" battalions. The old term smacked too much of passive, defensive tactics.[12]

The new Tank Destroyer Center consisted of the Headquarters, Tactical and Firing Center, School, and Tank Destroyer Board. The Center was charged with developing doctrine, cooperating in the development of equipment, and organizing and operating the Firing Center, School, and Board.[13] Like the rest of the US Army, the Tank Destroyer Center entered a period of rapid expansion.

One of the problems during this period was technical intelligence. The US Army received very little information concerning enemy equipment during the first months of the war. However, the British began to share technical information freely in the fall of 1940, once they were convinced that the United States would become an ally. The Russians proved to be equally willing collaborators as far as German equipment was concerned, although they remained very

secretive about their own designs.[14] Despite Allied cooperation, technical intelligence remained a problem throughout the war.

With very few exceptions, such as the British discovery of the "V" weapons through aerial photography, technical intelligence depended upon the capture of German equipment, which could then be examined by the intelligence teams that the Ordnance Department provided to units in combat zones. If the captured equipment was important enough, it was shipped to the United States for further examination.[15] Thus, Germany's technical progress was only revealed after she had managed to put new weapons into production. But the collection of data was only part of the problem facing technical intelligence. Information had to be evaluated properly before it could be of use. The Ordnance Department's inefficiency in evaluating the characteristics of German tanks would lead to major problems later in the war. But in the rush to expand the US Army during 1941 no one could wait for improvements in technical intelligence. US Army leaders had to organize units and develop equipment based upon what the British, and later the Russians, learned in Europe.

The creation of a new arm during wartime was an extremely demanding job. To Andrew Bruce's credit, he managed to juggle all of the varied tasks successfully. He had joined the infantry in 1916, just after graduating from the Agricultural and Mechanical College of Texas. He served in a machine gun battalion of the 2nd Infantry Division during World War I and earned the Distinguished Service Cross, the nation's second highest award for valor. After the war, he served in various infantry assignments. Bruce also attended the Artillery School, the Command and General Staff School, and both the Army and Navy war colleges.[16] When Gen. Marshall asked for "visionary officers" in 1941, four years of experience on the General Staff, including leadership of its planning branch, put the forty-seven-year-old Missourian in the right place at the right time. He was a natural choice to head the Tank Destroyer Center.

While at Camp Hood, Bruce had to work under the scrutiny of Gen. McNair, for McNair maintained a close interest in what was largely his brainchild. Thus he wrote to Bruce: "I personally will give my time without stint if there is anything I can do, since the TD command is very, very high in my scale of priorities."[17] As further proof of his interest, McNair saw to it that his son, Douglas, was assigned to Bruce's command. Another letter suggests a personal relationship between McNair and Bruce. While bemoaning that

Douglas, a Lt. Col. of Infantry, would leave the tank destroyers to accompany Bruce to the 77th Infantry Division, McNair asked Bruce to "Please make a good chief of staff out of him, for he is certainly not one at this moment."[18] McNair's interest in the tank destroyers was undoubtedly both helpful and trying to Bruce. Bruce could expect support, but he could also expect every mistake to be noted.

By the end of December 1941, Col. Bruce had managed to assemble a skeleton staff at Fort Meade. He and his staff selected a permanent site during January 1942 at Killeen, Texas, but the Center did not officially move there until 14 February. Even after the Center had moved, it had to stage its operations from Temple, Texas, since there were no facilities at the Killeen site, which had been christened Camp Hood. Some of the civilians who owned property on the site had to be forcibly removed. The first tank destroyer battalions, which arrived at Camp Hood in March and April of 1942, had to move into field sites on the reservation and use materials from old CCC camps for construction. The completion of a limited number of buildings finally permitted the Headquarters of the Tank Destroyer Center to move into Camp Hood on 20 August 1942. Despite its problems, the Tank Destroyer Center managed to train forty-two battalions by 13 April 1943.[19]

One of the most significant accomplishments of the Tank Destroyer Center during this formative period was the completion of Field Manual 18–5, *Organization and Tactics of Tank Destroyer Units,* published in June 1942. This manual provided the doctrine for all tank destroyer units. It was the clearest presentation of American anti-tank concepts before United States involvement in combat. Even after the war, the men who had developed the doctrine in FM 18-5 steadfastly supported it. Representatives of the Tank Destroyer Center made this comment after the war:

> Although this manual has since been revised, tank destroyer officers most closely associated with the development of tank destroyer doctrine and tactics, some of whom have observed tank destroyer units in action overseas, believe that the basic doctrine set forth in this first edition of Field Manual 18-5 was, and is, correct.[20]

The organization outlined by FM 18–5 was, in effect, a combined arms team organized as a battalion of 842 men. The combination of arms extended down to the level of the platoon. Each platoon

had four sections. The base of the platoon consisted of two gun sections, each with two guns. A security section, mounted in two armored cars, protected the flanks of the platoon and, as an additional duty, performed reconnaissance. An anti-aircraft section of two vehicles protected the gun sections from enemy aircraft, which were reported to accompany every German tank attack. The platoon leader rode in his own armored car, and the platoon also had an extra vehicle for ammunition.[21]

The tank destroyer company was composed of three tank destroyer platoons with a total of twelve guns. Two of the platoons were heavy; one was light. The only difference between them was their respective gun sections. The light platoon had 37-mm anti-tank guns, and the heavy platoon had 3-inch or 75-mm guns. The company, totaling 170 men, also possessed elements for various services including motor maintenance.[22]

The battalion's headquarters company supported the battalion staff and provided the normal battalion services, such as transportation. Three similarly organized tank destroyer companies formed the basis of the battalion. Although infantry and tank battalions had only one scout platoon for reconnaisance, the tank destroyer battalion had a company.[23] The reconnaissance company with three platoons, was intended to scout ahead of the battalion to find routes and firing positions, as well as to protect the tank destroyer companies from surprise. Each reconnaissance platoon had two sections, each with an armored car and several light vehicles. In addition, the reconnaissance company had a pioneer platoon whose primary function was to aid the movement of the battalion by construction work and removal of obstacles; it could also lay minefields.[24] Thus, the tank destroyer battalion possessed a combination of artillery (anti-tank guns), mobile infantry (security sections), and mechanized cavalry, not to mention the anti-aircraft and engineer elements.

In addition to the organization of battalions, FM 18-5 also explained the organization of group headquarters for tank destroyers. This was strictly a tactical headquarters of about company size. Its main assets were communications and a group staff. Intended to control several battalions (usually three), the group headquarters was designed for temporary assignment to major maneuver units, such as corps, to organize tank destroyer forces against a major tank threat.[25]

Aggressiveness was the watchword of tank destroyer tactics. As FM 18–5 described their role, "tank destroyer units are especially

designed for offensive action against hostile armored forces." However, "offensive" must be qualified in this case; the term actually meant a mobile defense. It did not mean, as it did in tank or infantry units, to close with the enemy. For tank destroyers, "offensive action consists of vigorous reconnaissance to locate hostile tanks and movement to advantageous positions from which to attack the enemy by fire." But the important distinction between attacking and attacking by fire went unheeded by some commanders, as evidenced by their use of tank destroyers in combat.[26]

Another integral aspect of tank destroyer doctrine was the tank warning net. This was a communications network, primarily radio, dedicated to the task of warning friendly units about the presence of enemy tanks. It was not a responsibility of the tank destroyers. The major maneuver units, such as corps or divisions, were expected to establish these nets, and available tank destroyers then reacted to the information.[27]

A scenario might best explain the operation of a tank destroyer battalion as prescribed by official doctrine. The battalion would receive word through the warning net of an enemy tank attack. Operating from a position in the rear, the battalion would dispatch its reconnaissance company to gain contact with the enemy force and inform the battalion of enemy dispositions and locations. The battalion commander would then move his tank destroyer companies to positions where they could bring the enemy under fire. The battalion would destroy the enemy armor or delay the enemy until enough tank destroyers could be assembled to destroy him. With prior warning, a tank destroyer group or groups in sufficient strength to counter the enemy armor could be assembled before the attack.

One important aspect of tank destroyer doctrine was to prove unacceptable to most division commanders. The tank destroyers were not to be used to defend the front lines. As FM 18–5 stated, "organic anti-tank weapons of front line units are used for this first line of defense; tank destroyer units form the mobile reserve."[28] This assumed penetration of friendly front lines, particularly since most US Army anti-tank assets had been concentrated in tank destroyer units.[29] All this was based on the lessons of the war in Europe as perceived in the United States. A massed tank attack could always penetrate a front line; it would be impossible to give the entire front enough anti-tank weapons to stop such a highly concentrated attack. So tank destroyers were not to be frittered away in linear defense,

but should remain in reserve so they could *concentrate* to stop the *breakthrough.*

As a corollary to concentration, tank destroyers were more oriented to the enemy force than to terrain. This was a most peculiar aspect of tank destroyer doctrine. Most ground combat units of battalion size estimated their objectives in terms of terrain. Tank destroyers, however, used terrain as a means and not as a goal.

Gen. McNair's concept of force-pooling assets was not specifically mentioned in FM 18–5. If a specific type of unit was not needed continuously by a division, it should not be made an organic part of the division. Such units, if assigned, were wasted when not in use. Therefore, McNair believed that special units should be pooled and attached to divisions as needed. This enabled the US Army to reduce the total number of such units and employ those available more economically. McNair applied the concept of force-pooling to anti-aircraft and separate tank battalions as well.[30]

This doctrine made it vital for tank destroyers to have mobility superior to tanks. Tank destroyers needed to move fast enough to intercept the enemy force, while avoiding close combat with tanks or supporting infantry. The tank destroyers also needed to arrive at the battlefield first in order to select firing positions. FM 18–5 stressed the advantage to be gained for tank destroyers by firing while stationary, preferably from covered positions, in order to fire much more accurately than moving tanks. The need for mobility persuaded the men of the Tank Destroyer Center to adopt self-propelled rather than towed guns. As FM 18–5 stated, "the primary weapons of tank destroyer units are self-propelled guns. . . ."[31]

There had been a long controversy over the relative merits of self-propelled and towed guns. Even as late as the Anti-tank Conference of July 1941, the matter had not been settled. Col. Bruce observed at the conference:

> As to the limbered weapon or the self-propelled weapon controversy, suffice it to say that *we shall have limbered weapons for some time to come,* but we shall develop and try-out the self-propelled mount.[32]

However, by the spring of 1942, Brig. Gen. Bruce (recently promoted) and his men had definitely decided on self-propelled guns.

But Gen. McNair, the main supporter of the tank destroyer concept, was a firm believer in the towed gun. Gen. Marshall had directed that a study be made of the possibility of developing a self-

propelled anti-tank gun. Early in 1941, Marshall remarked:

> It occurs to me that possibly the best way to combat mechanized force would be to create anti-mechanized units on self-propelled mounts, with emphasis on visibility (on the part of the gunner), mobility, heavy armament, and very little armor.[33]

But McNair was quick to disagree with Marshall's point of view. McNair had had considerable experience with an experimental self-propelled gun in 1930 and "felt no hesitation in condemning it." He believed that the advantages of self-propelled mounts were few and far outweighed by their disadvantages, as he indicated in the following comparison:

Advantages

1. Speed of entering action and withdrawing from it. The latter is a doubtful advantage, since such guns should stay, not move.
2. Protection of cannoneers by armor.

Disadvantages

1. Vulnerable target due to size.
2. Concealment in action difficult.
3. Unstable firing platform.
4. Probably slower due to weight.
5. Disability of either gun or motor renders both useless.
6. Greater weight (bridges).
7. Probably greater cost and slower production.[34]

Despite his strong views, McNair did not interfere with the decision to adopt self-propelled weapons for tank destroyers. However, the controversy was by no means settled in the spring of 1942. The decision to fix a wartime tank destroyer doctrine before the equipment was designed, let alone produced, was the most uncertain issue of all. FM 18–5 admitted that:

> It is prepared for the guidance of units that will be equipped with matériel now being developed; units equipped with substitute matériel must interpret and modify the provisions of this manual to fit their particular needs.[35]

Substitute equipment was to be the rule for tank destroyer units for nearly two more years.

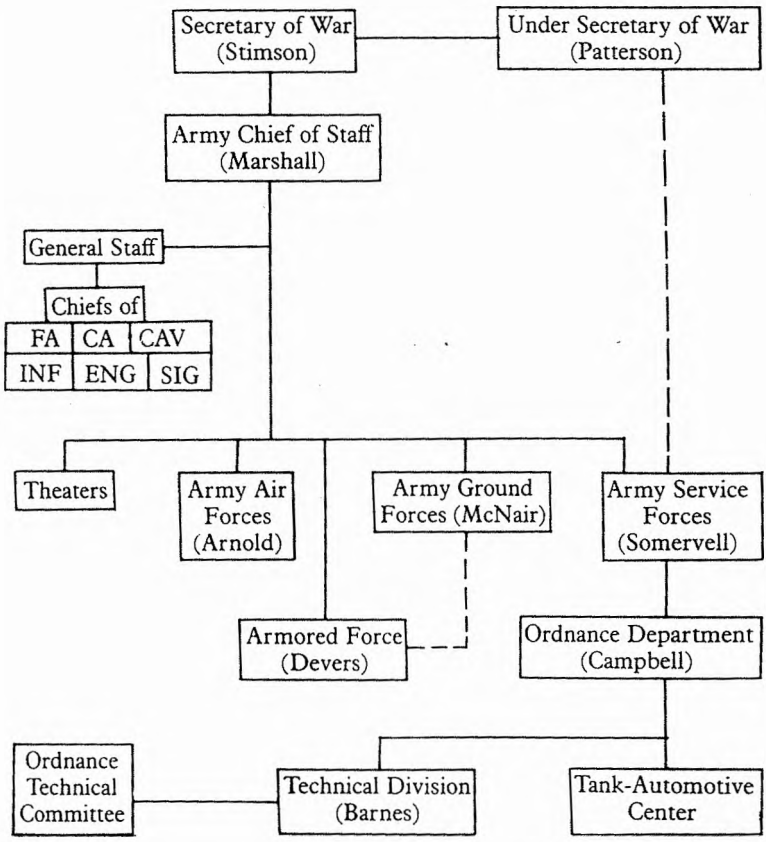
Thus the US Army, during the early years of World War II, had moved decisively and perhaps too audaciously to counter the threat of enemy tanks. By the fall of 1942, Gen. McNair's early concepts of a pool of mobile anti-tank guns were already hardened into tactical doctrine and organized units. But military technology could not immediately provide the necessary weapons.

The need for new weapons brought the Tank Destroyer Center into intimate and continuous contact with US Army organization for research and development. While decisions normally tended to proceed downward in the hierarchy, weapons development necessarily involved horizontal communication. The users of equipment did not have the facilities or expertise to produce that equipment. This was particularly true of items as complex as tank destroyers and tanks. Further, given the importance of these items to military thinking in World War II, they were not subject to easy compromise. To complicate Bruce's problems, he found AGF, his superior headquarters, to be an uncertain ally.

Along with responsibility for the organization, doctrine, and training of all ground combat units, AGF was also responsible for the characteristics of their equipment. This responsibility reflected the obvious need for equipment that was suited to the doctrine by which the combat units had been trained and organized to fight. For example, the heavy, lumbering *Jagdtiger* of the German Army was obviously unsuited to tank destroyer doctrine. Although AGF was not directly responsible for developing equipment, it had to approve the product before it could be produced in quantity. Successful performance in tests designed by the service boards (e.g., Tank Destroyer Board) was AGF's main criterion for assent.

Organization of AGF reflected the experience of the US Army in World War I and the early months of World War II. The GHQ, modeled on the headquarters of the American Expeditionary Force of World War I, quickly proved inadequate to command forces overseas. Gen. Marshall also found himself with over sixty agencies reporting directly to him. Appalled by these complexities, Marshall persuaded Pres. Roosevelt to issue an executive order reorganizing the Army. The results of that order are simplified in Fig. 1. It created three major commands in the United States: AGF, Army Service Forces (ASF, first called Services of Supply, SOS), and an autonomous air command, Army Air Forces (AAF). Forces overseas were the responsibility of theaters such as the European Theater of Operations (ETO).[36] The semi-autonomous status of the Armored Force will be explained later.

Fig. 1 ARMY ORGANIZATION



Although reduced, the responsibilities of the GHQ remained immense. The 220 divisions envisaged in 1941 were ultimately reduced to 90, but it was still a formidable task to organize and train them. As Chief of Staff of the GHQ, McNair was Marshall's obvious choice to command AGF. Training and organizational problems occupied most of McNair's time, but he continued to maintain an active interest in the development of equipment.

The Requirements Section of McNair's headquarters accomplished day-to-day coordination with development efforts. A general officer was always chief of the section. The Requirements Section, which reviewed and consolidated equipment needs of organizations

controlled by AGF, always reflected McNair's views. AGF steadfastly opposed producing tanks equipped with large anti-tank guns. If such a gun were needed, it belonged on a tank destroyer. Tanks were believed to be an offensive weapon employed through holes in the enemy's lines or against his flanks to envelop his forces and destroy his communications. Heavy tanks were unnecessary since artillery and infantry could open the holes in enemy lines. For the future, McNair and AGF remained open-minded. Referring to proposed modifications to an experimental heavy tank in 1943, McNair commented that:

> Development should not wait for the requirement to arise but should anticipate and provide for needs in advance. . . . Although there appears to be little requirement for heavy tanks at the present time there is no assurance that they will not be needed in the future. It is therefore believed that every effort should be made to increase the efficiency of this weapon without delay.[37]

Despite McNair's willingness to accept tank development, he could and did vigorously oppose production when he believed that unneeded or inferior equipment would end up in the hands of the troops. So the immediate attitude of AGF toward developmental tanks and tank destroyers was crucial. There was little point in developing a vehicle for which no production orders would be forthcoming. Since the agency responsible for developing both those vehicles, the Ordnance Department, was forced to depend upon AGF concurrence for their production, any differences of opinion over roles and characteristics tended to lead to disputes.

The principal antagonist confronting Gen. Bruce and AGF was Gen. Gladeon M. Barnes, Chief of the Technical Division (later renamed Research and Development Service) of the Ordnance Department. Similar to McNair in many ways, Barnes was sure of his judgments and passionate as a bureaucratic infighter. He had joined the US Army in 1910 as a twenty-three-year-old lieutenant of Coast Artillery. He soon transferred to the Ordnance Department and spent World War I designing heavy artillery. His post-war assignments gave him experience in both production and design, and he ultimately owned some thirty-four patents. Most of his experience involved various types of artillery, but he also worked with tank development. Attendance at both the Industrial War College and Army War College further broadened his education. After a two-

year stint in Industrial Services helping to organize production, he returned to the Office of the Chief of Ordnance in July 1942 and took charge of the newly formed Technical Division.[38]

Maj. Gen. Levin H. Campbell, Chief of Ordnance, formed the Technical Division from his technical staff after he became convinced that a separate organization was necessary in view of the large number of development projects, of which there would be over 1,000 during World War II. Barnes manned the division with both Ordnance officers and civilian scientists, many of whom had donned uniforms as Reserve officers after Pearl Harbor. He also enlisted the services of many eminent civilian scientists in as many research projects as possible—with some outstanding exceptions, including tank development. Aided by the president of Chrysler Motors, he fended off the efforts of the National Defense Research Council to "interfere" with tanks.[39] But Barnes stayed on good terms with the NDRC. He twice served as the liaison officer with that organization, which grew into the powerful Office of Scientific Research and Development. The NDRC had so much to do elsewhere that the rebuff concerning tanks was probably not a matter of major concern to it. But Barnes also tried to exclude US Army agencies from tank development, and this created problems.

Barnes gained influence in excess of his organizational position by occasionally going outside of his chain of command to air his views. Once he went directly to Henry L. Stimson, Secretary of War, to have a piece of equipment sent overseas. He was aided by Stimson's close interest in developmental equipment, through which Barnes first became acquainted with the Secretary.[40] Even so, jumping channels was not standard procedure for Barnes. He generally worked through Campbell and ultimately through the Ordnance Department's superior headquarters, ASF. Campbell regularly agreed with Barnes on development matters, but Barnes was less successful with ASF.

The reorganization of the Army in 1942 reduced the influence of the Ordnance Department by introducing ASF between the Chief of Ordnance and the General Staff. Despite AGF influence, ASF was the source of production and development orders. AGF had no *direct* control over the development or production of tanks or tank destroyers; it only established the requirement.[41] ASF exercised the requisite control. However, ASF consistently refused to order production without AGF concurrence and often sided with AGF on disputed issues. ASF was less involved in the controversies over tank

and tank destroyer development because that headquarters generally was not interested in specific characteristics. There was certainly no lack of firm leadership at the top of ASF. Lt. Gen. Brehon B. Somervell was renowned as a "ruthless expediter" who was capable of "running down those who got in his way."[42] But Somervell never championed the Ordnance Department's concepts of tank development.

Members of the Ordnance Department had a twofold solution to tank development based on their experience with the design and testing of tanks during the inter-war years. First, Barnes and the Ordnance Department became convinced before Pearl Harbor that a heavy tank would be required for modern war, and they went on to develop and advocate production of heavy tanks throughout the war. Second, most of the energy from engineers of the Ordnance Department was expended on a program intended to replace the M4. This program, the T20 series of developmental tanks, became the main focus of tank development in the United States. The views of Barnes and other Ordnance officers were represented in the characteristics of those tanks, and Ordnance officers worked hard to force their views and their tanks on the combat arms. Col. G. MacLeod Ross, Britain's Chief technical liaison officer in America for tanks, observed that "it was Ordnance which decided what was good for the user in terms of weapons . . . neither Staff nor user got a sympathetic hearing from Army Ordnance."[43]

Lack of pre-war experience with tank destroyers did not prevent the Ordnance Department from pressing its views in that area, even if it meant ignoring the stated desires of the user. Relations between Bruce and the Ordnance Department became increasingly bitter. He resisted what the Ordnance Department considered to be good tank destroyers, although Ordnance seemed to have no consistent view of such a vehicle. In the midst of this bitterness, the Ordnance Department found an occasional ally in the Armored Force.

Although the US Army had experimented with mechanized forces during the inter-war years, it had not created a branch, such as Infantry or Cavalry, for tankers. The National Defense Act of 1920 recognized the lessons of World War I by authorizing such new branches as the Chemical Corps and Air Corps, but it forbade the creation of further branches. Both chemical weapons and aircraft were highly technical and had been major factors in the build-up for World War I. Tanks were not as exotic and had not been as

important. Gen. Marshall did not ask the Congress to change the law, even after German victories in Europe made it apparent that modern war required tank formations. Such a request would have exposed internal bickering over the subject at a time when Marshall needed Congressional support for the more important objective of US Army expansion. Therefore, with little fanfare, the Armored Force was established on 10 July 1940 as a semi-autonomous organization based on the experimental mechanized unit at Fort Knox, Kentucky. The War Department deferred efforts to give the Armored Force the independent status enjoyed by the AAF.[44]

Lack of a branch for tankers during the inter-war years was a serious problem for American tank development. Although a cavalryman might have been interested in tanks, his survival in the army depended on a visible loyalty to horses. He could have been assigned to a mechanized unit before 1940, but promotion depended upon a significant part of time in horse cavalry. An infantryman was similarly kept from becoming too involved with tanks. The result was that the only men with continuous experience with tanks during the 1920s and 1930s were in the Ordnance Department. This experience buttressed the Ordnance Department's view that the men in the newly created Armored Force were amateurs as far as tanks were concerned. AGF and the Armored Force encountered this attitude throughout the war, and their views were also less compelling because they did not present a united front.

The relationship of Fort Knox to the GHQ and McNair remained unclear. Although McNair supervised their training, he executed a personal, not official influence and generally left the Armored Force to its own devices.[45] The relation of the Armored Force to GHQ can be clarified by understanding the command relationship of Maj. Gen. Jacob L. Devers, Armored Force Commander, and Gen. Marshall.

Although an artilleryman, Devers had followed armor developments during the 1930s. He was busy organizing a division and building a post at Camp Bragg, North Carolina, in 1941, when he received a telephone call from Gen. Marshall. Marshall ordered Devers to inspect Fort Knox and then report directly to him. Devers found the Armored Force in some disarray. A good organization lacked leadership because the commander, Brig. Gen. Adna Chaffee, was mortally ill. Gen. Devers returned to Camp Bragg after reporting this to Marshall. Soon after arriving home, Devers received another phone call from Marshall ordering him to take command of

the Armored Force. Marshall told Devers to avoid the GHQ and again report directly to him. Thus GHQ had little effective control over the Armored Force, although GHQ was responsible for the latter's training. Devers's relations with the GHQ were smoothed by the fact that he and McNair were close personal friends, and he consulted with McNair whenever he was taking some action that affected the GHQ.[46]

While Devers commanded the Armored Force, the Ordnance Department generally coordinated tank development with Fort Knox. After the creation of ASF in 1942, Devers noted that "McNair was out of the picture." A big, ebullient man, Devers believed in fast action coordinated by telephone, avoiding the red tape of "all those damn letters." The relations between the AF and the Ordnance Department were generally smooth although they did not always agree.[47]

The Armored Force suffered a sharp drop in status after Devers departed in May 1943 to take command of ETO. The new commander, Maj. Gen. Alvan C. Gillem, did not enjoy direct access to the Chief of Staff. McNair moved speedily to bring the Armored Force under the control of AGF and renamed it the Armored Command. Although the Armored Command retained its equipment testing organization, the Armored Command Board, it was reduced to the same status as other Commands under AGF, e.g., Tank Destroyer and Anti-aircraft. The demise of the Armored Force's independent voice in tank development became complete in February 1944 when the AGF Requirements Section took control of the Armored Board, and Armored Command was reduced to a training headquarters, Armored Training Center.[48]

During the period that it was still independent, the Armored Force agreed and disagreed with both AGF and Ordnance. Like AGF, it believed a heavy tank was not required and that tanks should avoid duels with other tanks. However, the Armored Force believed that tanks might occasionally be forced to fight enemy tanks:

> Attacking tanks frequently encounter hostile tank units unexpectedly. At other times they may be required to attack hostile tanks deliberately in order to break up an attack or a counter-attack.[49]

This suggests that the Armored Force was clearly more concerned than AGF about the anti-tank capabilities of their tanks.

Despite the subsequent disappearance of the Armored Force, another agent was sporadically important to tank development. The G-4 Section of the General Staff monitored tank development closely. Although rarely a party to disputes, the G-4 acted as the final arbiter. Through the G-4, Gen. Marshall influenced development. Marshall judged that his chief contribution to arming the troops was through direct intervention.[50] Although he did not take the initiative in development details, Marshall was always interested in the subject. Finally, Marshall's occasional participation in disputes over development was always decisive.

The official organ for coordination between those interested in development was the Ordnance Technical Committee (OTC). All service branches sent representatives to committee meetings where they had the opportunity to review any experimental item of equipment before it was standardized. The approved Ordnance Technical Committee Minutes (OCM) justified all development and production actions. Since the OTC finally served only to formalize decisions already made, its records reveal little of the controversy behind those decisions. The most important arguments were usually settled before OTC meetings, which were clearly dominated by the Ordnance Department. Gen. Barnes always chaired the meetings and the branches were typically represented by lieutenant colonels.[51]

At this point it might clarify the research and development organization to trace the path of a hypothetical piece of equipment through the organization. A subordinate command of AGF, perhaps, the Tank Destroyer Center or the Armored Command, might decide that a new armored vehicle was required. This decision would then be reviewed by AGF. Following AGF's approval, the specifications went to the OTC. There the Engineers might tell the committee that no bridge would hold the proposed vehicle or the Signal Corps might point out that it lacked a radio. After the OTC settled such problems, it approved the new vehicle. AGF would then ask ASF to develop the new item. Of course, the G-4 of the War Department supervised all of this on behalf of Gen. Marshall. ASF in turn ordered the Ordnance Department to develop the new item. During development there might be several repetitions of this cycle to deal with modifications. If the vehicle were a success, the OTC recommended that the G-4 standardize it. Then AGF could request ASF to produce the vehicle in large quantities, and ASF would order the Ordnance Department to do so. In summary, the user asked for a weapon with certain characteristics and then the Ordnance Department would design and develop it.

So much for theory. Insofar as tanks and tank destroyers were concerned, this fairly straight-forward process rarely occurred. The Ordnance Department was inclined to design and develop equipment without referring to the users. So two types of equipment were developed during World War II: what the user wanted and what the Ordnance Department wanted. In the case of tank destroyers, the US Army would receive both types; in the case of tanks—neither.

The combat forces overseas were conspicuously absent from the development process. Theater commanders had no institutional method to influence equipment development except by appealing directly to the War Department. The Ordnance Department received most of its operational information from Ordnance officers in the field with combat units.[52] Through personal letters to Barnes and others in the Ordnance Department, these men expressed their views about the equipment needed in combat. Combat officers also wrote to friends in the Armored Force or AGF. Numerous overseas trips by observers from Ordnance, AGF, and the Armored Force were another major source of information. The resulting views were necessarily based on limited observation and interviews that became increasingly obsolete as the interval after the trip lengthened. Combat units were infrequently queried, and, until things went wrong, they seldom offered advice to developers. The lack of regular comments from field commanders to American equipment developers was a weakness in US Army wartime development procedures, but the judgments of the men in the combat zones would prove to be little better than those in the United States.

When the commanders overseas did respond, their comments were often of little use. Men facing an enemy have more immediate problems than theorizing about equipment needed in the distant future. Their thoughts were confined to present needs and problems. They were also too busy to absorb the experiences of other units or intelligence about the enemy. Their comments, by the time they reached the United States, concerned the most recent battle—not the next.

The fact that the combat forces did not have much experience with armored combat contributed to the lack of information flowing back to the United States. American experience against large German armored formations was very limited until late in the war. This relates directly to the main criticism of both tanks and tank destroyers: inability to compete with the Germans in this type of fighting.

2

Developing Tanks and Tank Destroyers 1942

The United States found itself in 1940 with virtually no tanks and, more importantly, no factory that could build them in large quantities. The first thing was to create production facilities. Such factories as the Detroit Tank Arsenal were the result. Since production posed the major problem, there was little time to refine tank designs; the United States built what it had, the M3 light tank and the hastily designed M3 medium. Only the M3 light tank, and its refined version the M5, were viewed as fully satisfactory to the tankers. The limitations of the M3 medium and its sponson-mounted gun were evident. A replacement, the M4, was designed before the M3 entered production. When the British first used M3s in combat at Gazala, Libya, in 1942, the M4 was already in mass production.

The M4, a further refinement of the M2 and M3, featured a turret with the 75mm gun of the later M3s. During 1942, the most important task for the Ordnance Department, Armored Force, and AGF was to produce enough of the M4, popularly known as the Sherman. This fine vehicle compared favorably to the Russians' vaunted T-34, which was similarly armed and armored. Indeed, the mobility problems caused by the M4's narrow tracks were less important than the tactical problems caused by the two-man turret in the T-34, which forced the tank commander to perform the duties of both gunner and commander. Production problems were eventually solved, and over 40,000 M4s were built during the war. They fought from the deserts of North Africa to the jungles of New Guinea and proved to be a reliable, effective weapon. They were the most important tank in the US and British Armies, and Russia received nearly 7,000 of them. Despite the criticism of this tank, many participants in the war defended the M4. Perhaps Gen.

Fig. 2. Sherman tanks in Italy, 1944. Source: US Army Photo. (All references to US Army Photo indicate the Still Photograph Library US Army Audio-visual Activity, the Pentagon.)

Devers, who commanded the 6th Army Group during the last months of the war in Europe, provided the best assessment: "It did the job."[2]

Of course the M4 was not the only tank developed in the United States during World War II. Before the M4 entered production, the Armored Force was already pressing to replace it. During 1941 and 1942, the Armored Force directed most of its development efforts towards the M7 medium tank, apparently intended to match the German Mark III. The M7 began development as the T7 light tank in February 1941 before the Armored Force seized upon it as the replacement for the M4. Devers told Somervell in January 1942 that he was in favor of only one tank, a 20-ton tank with the 75-mm gun, and the T7 would fill the need. Devers believed that the T7 should be altered to take the 75-mm gun and termed it "the tank of the future."[3] By modifying the T7, Devers expected to combine the firepower and armor of a medium tank with the speed and maneuverability of a light tank. By August 1942, before Armored Force tests, the tank was standardized and orders for 3,000 of them were

placed with the International Harvester Company.[4] During November, Devers went so far as to say that Sherman production should be cut if that was necessary to expedite production of the M7.[5] But when the M7 finally reached Fort Knox for tests in January 1943, Armored Force officers found that a promising light tank had grown into a mediocre medium tank. The M7 exceeded its specified weight and was inferior to the Sherman in nearly every respect.[6] Further development promised only to match, not surpass, the M4. On 16 March, Devers bravely asked AGF to have M7 production terminated as fast as possible. Meanwhile, International Harvester had built a plant and hired labor to produce the tanks. Despite the commitment, ASF terminated the contract in the last days of March, even as the first M7s rolled off the production lines. After this $16 million mistake, McNair agreed with Maj. Gen. Richard C. Moore, Chief of the Requirements Section, who simply commented: "This is a *mess*."[8] The attitude around AGF Headquarters was reflected by the remark:

> The Ordnance Department is not entirely blameless in this matter. They have been too prone since the War started to recommend standardization and procurement without adequate field tests.[9]

The fate of the M7 reveals not only the growing acrimony between equipment users and the Ordnance Department, but also something about the users' concepts of tank development.

Fig. 3. The T7 tank, still armed with the 57-mm gun. Source: *M7 History.*

The Armored Force's conception of the M7 showed a lack of vision. The M7 was a technological dead end. Even if it had met its specifications, the M7 would hardly have been better than the M4. The M7 was slightly faster, lighter, and enjoyed a lower silhouette, but it had the same gun as the M4 and thinner armor. The M7 would have solved none of the problems that later caused so much criticism of the M4, and the M7 would probably have been harder to modify with larger guns or heavier armor. If the M7 could have magically appeared in steel in 1942 when Devers demanded it, it would have been more than a match for the most numerous German tank of the day, the Mark III. But the M7 could not have been produced in numbers sufficient for combat before late 1943. By then the Germans had already moved on to heavier and better armed tanks such as the Panther and Tiger.

This is not to say that German designers were blessed with far more vision than their American counterparts. Germans were rudely shocked during the summer of 1941 by the Russian T-34. German sources agree that the T-34 changed their conservative development program into the effort that produced the Panthers and Tigers.[10] The Mark III, conservatively armed with a short-barreled 50-mm gun when a longer, higher velocity weapon was available, was rendered suddenly obsolete by the T-34. Germany phased out the Mark III to meet the challenge of the T-34, for which the 75-mm gun of the Mark IV was devised.

Thus, the superiority of German tanks in 1944 was due more to experiences on the Eastern front than to German foresight. During 1941 and 1942 the Germans and Russians were already embarked on a gun-armor race, while American designers still depended on British experience. The inadequacies of German and Russian materiel were quickly revealed by large, frequent tank battles. Appropriate modifications were immediately demanded by the troops. Both countries fought their battles relatively close to their technological bases, not separated by 3,000 miles of ocean.[11] Even after the United States entered the war, her forces did not experience the frequency or scope of armored warfare that was commonplace on the Eastern Front. But this lack of experience could not be permitted to stop development efforts in the United States.

Before the first M4 tank appeared on the battlefield, the Ordnance Department began designing its replacement, guided by observations of tank operations in North Africa. Such persons as

Col. Colby, who returned from a trip to the Middle East in April 1942, outlined the characteristics of the new vehicle.[12] Formal approval for a prototype of the new tank, termed the M4X, came from the Services of Supply (the later ASF) on 24 May 1942.[13] Ordnance engineers completed a wooden mock-up the same month.[14] The M4X evolved in a number of related prototypes generally termed the T20 series.

Convinced that a low silhouette was vital, Ordnance engineers sought to reduce the size of the M4X through a design technique called space engineering.[15] Since most of a tank's weight is represented by the armored surfaces of the hull, reducing the size also meant that thicker armor could be used without increasing the weight of the tank. However, since the hull must be large enough to contain the tank's crew, weapons, engine, and fuel, there are limits as to how much the size of the hull can be reduced. Concepts of space engineering hold that a given volume can be most efficiently contained with minimum surface area by a cubical shape. Thus Ordnance engineers arrived at a box-shaped hull for the M4X, eliminating the sponsons of the M4. Box hulls were a feature of the entire T20 series and every American tank for three decades afterwards.

Representatives of the Armored Force were conspicuously absent from the initial meetings concerning the design of the T20. One might have expected Ordnance officers to solicit the views of the US Army's principal tank agency, but this was not the case. For its part, the Armored Force seemed willing to allow the Ordnance Department to pursue an independent development program, probably because the M7 still seemed to be the most promising new tank. Although Gen. Devers was allowed to view the mock-up of the T20 in May 1942, this hardly constituted active participation from the Armored Force.[16] The T20 series remained a mystery to the rest of the Armored Force until 18 August when a formal conference at Fort Knox introduced the new design to the tankers.[17] With little chance to influence the basic design of the T20, the Armored Force was obliged to accept the tank as conceived by Ordnance engineers.

The Ordnance officers grudgingly accepted, rather than actively solicited, participation of the Armored Force in the development of the T20, despite the failure of the M7. The last fact explains much of the subsequent lack of enthusiasm of the officers of the Armored Force for the new tank. They were convinced that the box hull

sacrificed too much crewspace and ammunition to gain a low silhouette.[18] The conference mainly succeeded in establishing agreement that three interchangeable turrets would be constructed: a 76-mm gun version, an auto-loading 75-mm gun version, and a 3-inch gun version.

Besides the interchangeable turrets, Ordnance engineers decided to experiment with various transmission systems. Honoring a suggestion from Gen. Devers on 18 September, they also agreed to install a torsion bar suspension system in one prototype.[19] In October 1942 the Ordnance Technical Committee agreed to development of three versions of the T20: T20, T22, and T23. In addition, the designers decided to drop the 3-inch gun turret since the 76mm gun proved to be successful. The versions of the T20 series are summarized in Table 1.[20]

TABLE 1.

Selected Models of the T20 Series. The basic tanks (no "E" suffix) all had a common hull and the 76-mm gun except for the T25 and T26 (both 90-mm guns). The logic of the "E" suffixes is as follows: no suffix—basic tank, E1—75-mm autoloading gun, E2—3-inch gun (none constructed), and E3—torsion bar suspension. The tanks listed below reached at least prototype stage.

T20	76-mm gun and torquematic transmission[21]
T20E3	T20 with torsion bar suspension[22]
T22	76-mm gun and Sherman transmission
T22E1	T22 with 75-mm autoloading gun
T23	76-mm gun and electric drive
T23E3	T23 with torsion bar suspension
T25	T23 with 90-mm gun
T25E1	T25 with torquematic transmission
T26	T23 with 90-mm and heavier armor
T26E1	T26 with torquematic transmission
T26E3	T26E1 modified as a result of testing and standardized as the M26
T26E4	T26E3 with high velocity, T15 90-mm gun
T26E5	T26E3 with heavier armor

Work on the design continued smoothly during the last months of 1942. Complaining about difficulties in securing materials, Col. Colby wrote to Services of Supply on 16 September 1942, asking for a higher priority than AA3 for the T20 series.[23] Only two weeks later the US Army-Navy Munitions Board granted the highest priority, AA1, to the T20.[24] During the remainder of 1942 Ordnance engi-

neers worked to complete prototypes while the Armored Force continued to be preoccupied with the M7.

The M4 answered current needs while the Armored Force developed new weapons, but the situation of the tank destroyer was not nearly as happy. Tank destroyers were a new concept without the background of inter-war design and engineering. Indeed, no one was sure exactly what a tank destroyer should be, and the Tank Destroyer Center would not have the luxury of peacetime maneuvers and extended study to find out.

As Gen. Twaddle pointed out at the Anti-tank Conference in July 1941, the problem of equipping tank destroyer units involved two phases: first, making use of what was immediately available; second, developing weapons to go beyond any foreign developments. Col. Bruce agreed with Twaddle and emphasized that the two problems should be handled simultaneously rather than successively. Even though Bruce knew that development would take years, he described the characteristics of the "ideal tank destroyer":

> What we are after is a fast-moving vehicle armed with a weapon with a powerful punch which can be easily and quickly fired and in the last analysis we would like to get armored protection against small arms fire so that this weapon cannot be put out by a machine gun.[25]

But his comment that the "super-duper" tank destroyer would have its gun "pointing to the front or in a turret" illustrated that the vehicle was still only an idea. He expanded his ideas with a naval analogy:

> The tank destroyer that we have in mind is in reality similar to the battle cruiser. Its tactics in operating against the tank (the battleship) have to be different from the tactics we would employ in operating the tank (the battleship) against the tank (the battleship). Speed, visibility, and hitting power of the tank destroyer should compensate to some degree [for] its lack of armor. The tank destroyer must be cheaper in time and material for production than the tank.[26]

Col. Bruce (and later the officers of the Tank Destroyer Center) realized that the ideal tank destroyer would take many months to develop, but the characteristics mentioned by Bruce in the summer

of 1941 were significant in its evolution. Doctrine was written for the ideal tank destroyer; Bruce's characteristics guided development efforts of the Tank Destroyer Center. Moreover, proposed or interim weapons were measured against the same characteristics.

During the Anti-tank Conference, Bruce mentioned those weapons that were immediately available in reasonable quantities. Most important were the 37-mm gun, then the standard anti-tank gun, and the 75-mm gun which was to be replaced as the standard field artillery piece. The major problem with both weapons was finding means to make them self-propelled. Bruce also mentioned efforts being made to mount the 3-inch anti-aircraft gun on limbered and self-propelled carriages, but noted that none of those weapons would be available before the spring of 1942.[27] In its early days, the Tank Destroyer Board struggled to bring different versions of the three weapons to completion.

When the Board was established on 1 December 1941, there were eight types of 37-mm gun carriages, two types of 75-mm gun carriages, and three types of 3-inch gun carriages under test or nearing completion.[28] Winnowing out the best of the various carriages was the Board's first major task. The most complete carriage was the one for the 75-mm gun, the T12. A prototype of this vehicle had been completed in time for inspection at the Anti-tank Conference. It was merely a 75-mm gun mounted on a half-track, a combination finally standardized as the M3.

Inspiration for the M3 had come from a French designer who told Col. Bruce that the French Army had successfully mounted 75-mm guns on the back of trucks. The idea interested Bruce and other members of the Planning Branch, who saw the US Army's new half-track personnel carrier at Aberdeen a few days later. Soon after that, Gen. Twaddle and Ordnance officers agreed to try out the mount.[29]

Despite its hasty beginning, the M3 was successful. By 1 December, eighty-six had been completed, and fifty of these were immediately sent to the Philippines. The remainder equipped the first provisional tank destroyer unit. However, Col. Bruce had made it very clear at the Anti-tank Conference that the weapon was an expedient.[30] But it made good use of the 75-mm guns available and offered suitable equipment for training. As things turned out, the M3 was still standard equipment for tank destroyer battalions in early 1943.

The M3 did not have all of the desired characteristics for a tank

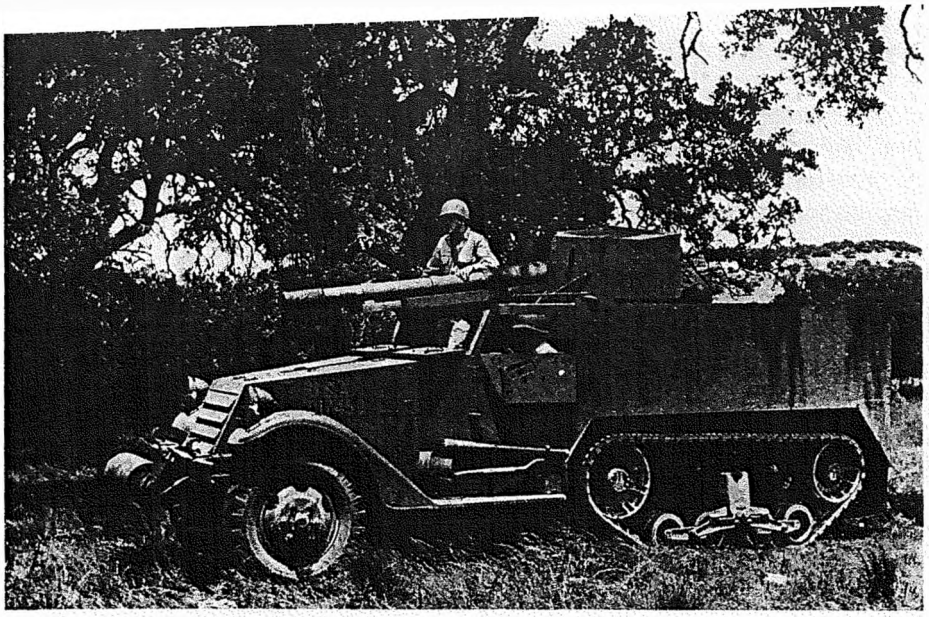


Fig. 4. The M3. Source: *TDC History*.

destroyer. Its thin sides and gunshield offered protection against small arms fire only, but not even then if armor piercing ammunition was used. More mobile than tanks only on roads, the M3 was disappointing when operated cross-country. Its best feature was its gun. The venerable 75-mm gun proved to be adequate against virtually all the enemy tanks that it faced in 1942. And there were good supplies of major types of ammunition, e.g., high-explosive, armor-piercing, and smoke.[31] The gun's main weakness was its relatively low velocity (2,000 fps). Its resulting curved trajectory made range estimation critical, a particularly difficult task against moving targets. Still, the M3 was the best gun motor carriage available during 1942.

Efforts to provide a carriage for the 37-mm gun were less successful. Most of the proposed carriages were small trucks. Light 1/4-ton trucks could not withstand the firing of the gun, while heavier, armored vehicles required long development periods. The compromise was the Fargo, a shielded 37-mm gun mounted on a pedestal in the back of a Dodge, 3/4-ton truck.[32] The Tank Destroyer Center intended to use the Fargo, designated the M6, only in training.[33] But the first tank destroyer units to arrive in North Africa still had the vehicles. The wisdom of restricting the Fargo to training would be proven in combat.

Fig. 5. The M6 in Arkansas mud, 1942. Source: US Army Photo.

By far the most serious defect in the M6 was its lack of armor. The vehicle was vulnerable to all types of fire, and the problem was accentuated by the short range of the 37-mm gun, which made a close approach to the enemy imperative. Moreover, a four wheel drive truck simply could not match the cross-country mobility of tracked vehicles. Yet the M6 was cheap and, above all, available.

Neither the 37-mm gun or the 75-mm gun were to remain as mainstays of tank destroyer firepower, each giving way to the 3-inch gun, an obsolete anti-aircraft weapon. Originally designed for seacoast defense, the 3-inch gun had been adapted for anti-aircraft use. It was employed in that role during the inter-war years. By 1940, the 3-inch gun was no longer in production. Its replacement, the 90-mm, was already in sight, but production could have been quickly resumed since all the necessary tools and dies were in storage. Like the 75-mm ammunition, 3-inch rounds were already perfected. The high velocity (2,600 fps) necessary for fire against aircraft made the 3-inch gun a natural choice for use against tanks.[34]

Significantly, Col. Bruce began to favor high-velocity guns more for their flatter trajectory in relation to the 75-mm, rather than for their greater penetrative power.[35] As Gen. McNair pointed out in 1941, "The prime essentials of an anti-tank gun are unusually clear-cut: first, to *hit;* second, to *penetrate* upon hitting."[36] During 1942,

the 75-mm seemed to have adequate penetration qualities. For example, Gen. Barnes reported after a visit to North Africa that "the 75-mm gun in the M-4 tank has destroyed the best German tanks at ranges as great as 2,500 yards.[37]

While searching for other means to achieve flatter trajectories, the Tank Destroyer Center also considered the 57-mm anti-tank gun, which was being produced in the United States during 1942 for British requirements. (See Appendix II for characteristics of anti-tank guns.) The 57-mm offered virtually the same penetrative capabilities as the 75-mm, but with greater velocity (2,750 fps). However, there were reports that the gun's solid shot shattered against the face-hardened armor on German tanks.[38] A further disadvantage was the failure of the English to design high-explosive ammunition for the 57-mm.

Lacking an alternative, the 3-inch gun became the focus for increasing the firepower of tank destroyers. The increased penetrative capabilities of the 3-inch gun were a fortuitous adjunct to its flatter trajectory. With admirable foresight, Gen. Barnes had moved to adapt the 3-inch gun for anti-tank use in the fall of 1940. On 9 September, Barnes directed the Artillery Division of the Ordnance Department to draw a layout for the gun to be mounted on the carriage of the new 105-mm howitzer. Barnes predicted that "This combination might make a very satisfactory anti-tank gun of great power."[39]

By 26 December, the Ordnance Technical Committee approved the development of the 3-inch anti-tank gun. Sharp disagreement came from the Infantry Board at Fort Benning:

> In view . . . of the lack of information as to the need for a weapon with the great penetrating ability of the subject gun, the Chief of Infantry cannot agree that there is a need for anti-tank matériel of such great weight and consequential poor mobility.[40]

But development of the 3-inch gun continued despite opposition from the Infantry. On 22 October 1941, technicians at Aberdeen fired the first prototype. Less than a month later, 12 November 1941, the Ordnance Technical Committee recommended that the gun be standardized.[41] But the Field Artillery Board was far less enthusiastic after it received one of the guns in February 1942.[42] The most serious deficiencies discovered at Fort Bragg were difficulty in

traversing the weapon on hillsides and the position of handwheels, which made the gunners unable to traverse and elevate the gun while looking through the sight.[43]

Yet serious as these deficiencies were, they were not to be the main problem with the 3-inch gun. AGF requested that production of the 3-inch gun be cancelled on 13 May 1942, and this request was approved by SOS on 21 May.[44] Gen. Campbell, Chief of Ordnance, strongly protested. Brig. Gen. Lucius D. Clay, Assistant Chief of Staff for matériel at SOS, answered him in a memorandum on 26 July that enumerated the technical deficiencies of the weapon. The clinching argument was that "the Tank Destroyer Center, sole users of the 3-inch anti-tank gun, consider it essential that this gun be self-propelled." Clay concluded: "This Headquarters feels that the decision to cancel the project for a towed 3-inch Anti-tank Gun was well considered."[45]

But the towed 3-inch gun was soon resurrected, after the failure of a self-propelled version of the gun. The Cletrac—the name was derived from its manufacturer, the Cleveland Tractor Company—had been developed in conjunction with the towed 3-inch gun. In 1940, the Cleveland Tractor Company submitted a design for a self-propelled gun developed from its high-speed tractor that was used to tow military aircraft. The Ordnance Technical Committee approved the idea on 19 December 1940, specifying that the vehicle would mount the 3-inch gun.[46]

The manufacturer could not deliver a prototype of the carriage, designated T1, until November 1941.[47] But numerous problems with the prototype did not stop the Field Artillery Board from recommending its standardization. The Ordnance Technical Committee concurred with the Artillery Board's recommendation on 24 November 1941. Significantly, the newly created Tank Destroyer Center did not comment on the recommendation, probably because the Cletrac was still considered to be an artillery weapon. The War Department approved standardization of the Cletrac as the M5 and directed procurement of 1,580 vehicles on 7 January 1942.[48] Numerous modifications failed to correct its original deficiencies. In addition, its weight grew from the 8 tons originally envisaged to nearly 12 tons. The vehicle's speed fell proportionately. In May 1942 a modified vehicle at Fort Bragg exhibited various faults, including broken tracks and a propensity to set itself on fire.[49]

Despite the Cletrac's numerous faults, the Ordnance Depart-

ment went ahead with measures to put the vehicle into production. The M5 became an increasingly vested interest of the Ordnance Department. The completion of a factory to build Cletracs indicated the commitment of Ordnance officers to the future of the carriage.[50] However, none of this effort improved the Cletrac in the eyes of the officers of the Tank Destroyer Center. The Cletrac was intrinsically bad to Bruce and his men; its mechanical imperfections only made it worse. Protected only by a gunshield, the M5 was vulnerable to all types of fire. This condition was accentuated by carrying ammunition on the fenders and the fact that the gunner and loader rode in *front* of the shield. Further, the Cletrac's speed had fallen to 36 mph, no faster than light tanks of the day. Bruce derisively referred to the M5 as the "Gleak track."[51]

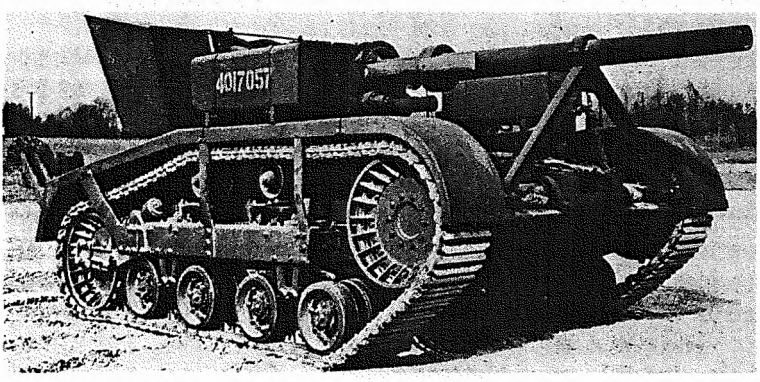


Fig. 6. The Cletrac. Source: US Army Photo.

Finally, in July 1942, a vehicle incorporating all of the changes deemed necessary was available at Aberdeen. A crew from the Tank Destroyer Board arrived to test the vehicle. The results of a cross country drive were disastrous. An Ordnance historian commented that "the sides were dished in, the gun supports buckled, the suspensions [were] out of line, the travel lock folded, and the gun mount loosened." Gen. McNair admitted to Bruce that the M5 looked "pretty hopeless."[52] Then on 23 August 1942, AGF recommended to SOS that production of the M5 be discontinued because it "is not a vehicle of sufficient capacity to handle the 3-inch antitank gun. . . . it is unsatisfactory for tank destroyer use."[53] But

nothing had been solved. The Cletrac's demise only created another problem for McNair's efforts to improve anti-tank defense.

On 1 July 1942, AGF decided to replace all 37-mm and 57-mm guns with self-propelled 3-inch guns.[54] The failure of the Cletrac left AGF without the desired substitute. The only available carriage for the 3-inch gun was the M10 gun motor carriage, which weighed some 30 tons. In the same letter that recommended abandonment of the Cletrac, AGF requested that

> in order to provide an additional anti-tank weapon of lighter weight than the M-10, it is desired that some of the 3-inch guns previously available for assignment to the M-5 be mounted upon the 105-mm howitzer carriage (towed).[55]

AGF asked for 500 towed 3-inch guns. So the failure of the Cletrac rekindled interest in the towed 3-inch gun, though the Tank Destroyer Center did not want the towed weapon. The heavy M10 had already become a bone of contention between Gen. Bruce and the Ordnance Department.

The M10 was initiated in October 1941 to mount the 3-inch gun in an M3 medium tank hull with very limited traverse. On 20 March 1942, the Ordnance Technical Committee agreed to develop a turreted carriage based on the M4 tank. The proposed vehicle, the T35, would be an M4 tank with lighter armor and a 3-inch gun mounted in a turret. Fisher Tank Division of General Motors managed to complete two prototypes in April and make the vehicles available for demonstrations at Aberdeen, Maryland. Various interested parties met there on 2 May 1942 to consider production of the T35.[56] Maj. Gen. Richard C. Moore, Chief of AGF's Requirements Section, Gen. Bruce, and Gen. Barnes were at the meeting. Both Moore and Barnes recommended that the T35 be placed in production, while Bruce disagreed vehemently.[57] Moore then overruled Bruce and convinced Gen. McNair to request production of the T35, which was soon standardized as the M10.[58] This was a sign to Bruce that he could not expect support from McNair on every issue.

Bruce's objections to the M10 were very simple. It "weighs too much and is too slow."[59] The M10 was barely faster than the M4 and slower than light tanks. Weight also restricted its mobility, limiting the types of bridges that it could cross. "At present," Bruce pointed out, "I am unable to shift a medium tank from several parts of Texas

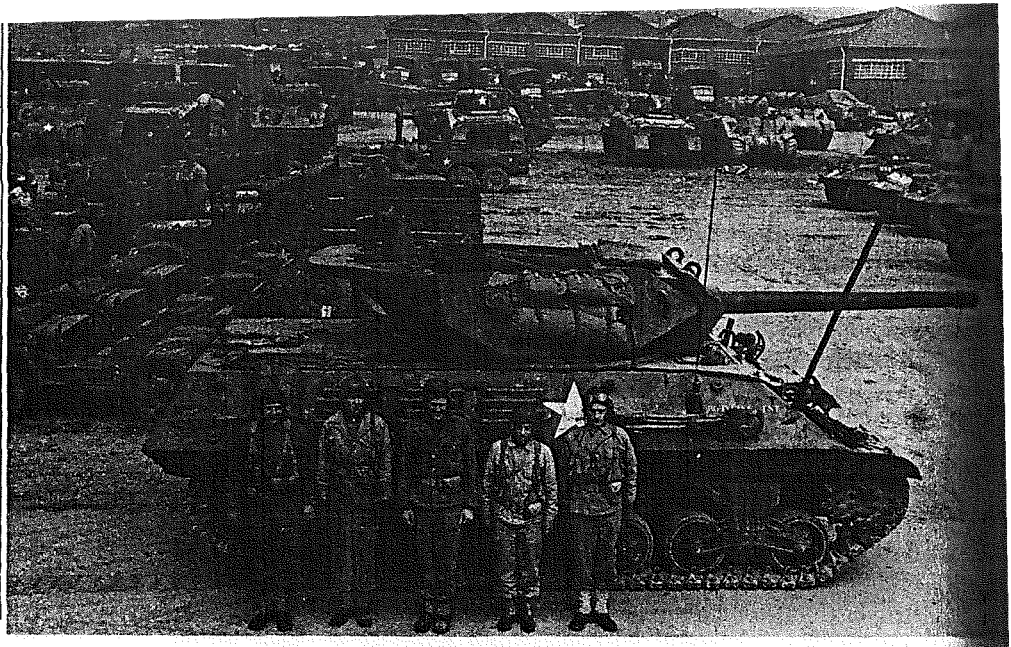


Fig. 7. The M10 in England, April 1944. Source: US Army Photo.

a distance of 20 miles without making a detour of 150 miles to find a bridge that will carry it."[60] In addition to its weight and speed, the M10 had other disadvantages, probably most important of which was the lack of power traverse. The overall imperfection of the design was exemplified by the counterweights hung on the rear of the turret to achieve balance.

The conference at Aberdeen exposed an increasingly bitter relationship between Gen. Bruce and the Ordnance Department. Gen. Bruce fought standardization of the M10 mainly because it was an expedient and partially because it was untested. He feared that accepting the M10 might delay or stop his efforts to get an ideal tank destroyer. As Bruce explained to Moore:

> This standardization thing gets my goat. When that is done they might suddenly order 3,000 guns on me. They might order those and stop seeking a better weapon.[61]

Bruce's misgivings were at least partially prophetic: the Ordnance Department ultimately built over 6,000 M10s. For all its faults the M10 would become, numerically, the most important tank destroyer in the US Army inventory.

The main objective of the Ordnance officers had been to produce enough 3-inch gun carriages to satisfy the requirements

handed down by the War Department, with little regard for the quality of those carriages. When General Bruce complained that "We have enough expedient weapons," Col. John K. Christmas of the Tank-Automotive Command retorted, "We do not have enough expedient weapons to finish up the SOS objective that we were given."[62] Apparently agreeing with the Ordnance Department, Gen. Moore cleared the way for production of the M10 despite Bruce's objections. England's tank expert, Col. Ross, would agree about the Ordnance Department's motives:

> . . . fear of incurring his [President Roosevelt's] indirect wrath seemed ever at the back of some officer's minds, to the result that they would pass weapons unfit for battle, rather than break the production promise which the Chief of Ordnance had put into the mouth of the President.[63]

The controversy between Bruce and the Ordnance Department continued until the former finally left the Tank Destroyer Center. During the remainder of 1942, the dispute was especially bitter. Bruce later wrote that, "The biggest obstacle to the creation of Tank Destroyers was found within the Ordnance Department."[64]

The Ordnance Department argued that Bruce did not make his requirements clear and asked for so many changes that development was delayed. Ordnance officers were not without support for their opinions. On 10 December, during a telephone conversation, Devers, who outranked Bruce, chastised him for not telling the Ordnance Department what the Tank Destroyer Center wanted. Bruce argued that his desires had remained the same since 1941, but Devers countered that characteristics were not enough and that Bruce needed to follow up on development efforts. Bruce clearly did not agree that he was flooding the Ordnance Department with unrealistic changes or failing to coordinate with the developers.[65] However, Gen. Moore supported the Ordnance Department's point of view. In reference to one development project, he commented to Gen. McNair: "I do not see how Bruce can ever expect to get any kind of mount for his 3-inch gun if he keeps asking for changes in design."[66]

Helping to clear the air, the Palmer Board eliminated several experimental vehicles that might have become matters of controversy. The Palmer Board was the unofficial name for the Special Armored Vehicle Board composed of representatives of the Armored

Force, Tank Destroyer Center, and Ordnance Department, which was in session from October to December 1942. The rush to develop fighting vehicles during 1941 and 1942 resulted in a hodgepodge of designs competing to satisfy the same requirements. Every design had supporters, and lucrative contracts were at stake. Gen. Barnes easily gained AGF support for a War Department Board which could simplify matters.[67]

Headed by Brig. Gen. William B. Palmer of the Armored Force, the board considered some fifteen armored vehicles in order to recommend those vehicles for service use, development, or termination,[68] several of which were of interest to the Tank Destroyer Center. The Board pared some nine armored cars down to one, the T22, which was standardized as the M8. The Tank Destroyer Center had been interested in this vehicle to replace the Fargo as a light tank destroyer.[69] However, the M8 was to be of better use as the standard armored car for cavalry units. Most importantly, the Board managed to select a single gun motor carriage. The two eliminated vehicles were a wheeled 3-inch gun carriage called the "Cook Interceptor" and a 3-inch gun mounted on an M3 light tank chassis.[70] Both would almost certainly have aroused Bruce's ire as further expedients. But the survivor, the T49, promised to become the ideal tank destroyer.

That vehicle had originated in February 1942 when Bruce's review of some 200 vehicles under test by the Ordnance Department did not reveal a single vehicle satisfactory for tank destroyer use. This made it necessary to develop the ideal tank destroyer from scratch. The driving force behind the decision to start afresh was the need for mobility. Volute spring and bogie suspension common to most of the US Army's tracked vehicles would not permit enough speed, since vibration became destructive at high speeds.[71]

Bruce conferred with an engineer from Buick Motors, and the two agreed that a Christie suspension was the answer. General Motors quickly designed a vehicle with a Christie-type suspension which was designated T42 and intended to mount the 37-mm gun. A decision on 3 April 1942 to substitute the 57-mm gun for the 37-mm also resulted in a change of designation, this time to T49. Since the T49 appeared to offer all of the characteristics desired for tank destroyers, Bruce coordinated closely with Buick Motors. He recommended that the armament be changed to a 75-mm gun on 2 July 1942, and this resulted in the further designation T67. On 3 September 1942, an example of the vehicle was available at Aber-

deen for tests. During the test, Gen. Barnes called Bruce's attention to the new 76-mm gun.[72]

This gun was a minor coup for Ordnance engineers. They had designed a new gun to fire 3-inch projectiles with the same performance as the 3-inch gun. The new gun was lighter, smaller, and used shorter, space-saving ammunition. Even more beneficial to tanks and tank destroyers, the 76-mm gun used the same breech block and recoil system as the 75-mm, thus making substitution relatively simple.[73]

Ordnance officers were enthusiastic about mounting the 76-mm gun in an armored vehicle. After discovering in September 1942 that the gun could be mounted in a M4 tank, Ordnance recommended, characteristically, that 1,000 such tanks be produced.[74] But Gen. Devers had too much clout to be forced to accept an unwanted vehicle, as had been Bruce's fate with the M10. Until the AF could test these "untried" vehicles, Devers would agree only to building twelve, enough for the tests.[75]

Gen. Bruce was more enthusiastic about the new gun. Shortly after the Palmer Board, Bruce met with representatives of industry and the Ordnance Department in Detroit, and they agreed on characteristics of a T67 armed with the 76-mm gun. The agreement included yet another change, torsion bar suspension which was lighter and simpler than the Christie type. The Ordnance Technical Committee approved the new development project, the T70, on 4 January 1943. Development of the ideal tank destroyer was finally underway after long months of effort and dispute during 1942.[76]

During its first eighteen months of existence, the Tank Destroyer Center had made great progress towards equipping its unique, new units. The two weapons that were immediately available, the 37-mm and 75-mm guns, had been adapted to self-propelled mounts. Both the M3 and M6 were useful for training, and the M3 would prove surprisingly effective in combat. But the Center's other development projects were slower and more controversial.

During 1942 the Ordnance Department had become increasingly independent of the users. The Ordnance Department clearly had its own views about what equipment was suitable, and it would press those views despite the users' resistance. Pursuing the M7, its own dead-end, the Armored Force had been no hindrance. The cooperation of AGF, which worked against Bruce in the Cletrac and

towed gun programs, turned into implacable resistance when the T20 tanks began appearing in 1943. But the worst controversies were still in the future.

Although there were disagreements about development in 1942, the US Army had made great strides towards equipping its tank and tank destroyer units. The 3-inch gun of the M10 would increase firepower in a short time, and the T70 was well advanced. But the first tank destroyer units would still have to fight with improvised weapons, the M6 and M3. Furthermore, an increasing number of Sherman tanks began to reach British and American troops, proving that vehicle's worth in North Africa.

3

Combat Experience in the Mediterranean 1942–1943

When American troops began fighting German troops in late 1942 they found a North African war different from the one experienced by the British from 1940 through 1942. In the flat expanses of Egypt and Libya tactics had been governed more by logistical difficulties than by terrain. The unobstructed expanses of Cyrenaica had always given the British and Germans an open, southern flank which permitted easy maneuvers. In contrast, the campaign in Tunisia involved a continuous front studded with easily defended chains of mountains. Therefore some preconceived doctrinal notions would founder in Tunisia. The place of the light tank in combat was to be among the first of them.

Light tanks were intended to be the most important weapon in American tank formation. There had been little evidence to dispel trust in light tanks during the first years of the war. Germany had used many light tanks, and the Russians were known to have thousands of them. Britain's Crusaders and lend-lease "Honeys" (American M3 light tanks) had had a good deal of success in the desert. But the increased effectiveness of German anti-tank weapons and the restrictive Tunisian terrain would leave faith in light tanks as riddled as the tanks themselves.

During the first weeks of the Tunisian campaign light tanks experienced a few limited successes because the German front was thinly manned. As German defenses thickened, light tanks became deathtraps. German tanks and guns could destroy American light tanks at ranges which did not permit any effective reply. At the end of the campaign, Lt. Gen. Omar Bradley commented: "Operations in Tunisia have indicated that the use of the light tank M5 in other than reconnaissance missions results in excessive losses." Gens. Patton, Eisenhower, and others concurred.[1] Light tanks were relegated to reconnaissance duties for the rest of the war, and their

numbers in American formations dropped drastically. American medium tanks were far more successful.

The Sherman tank received unstinting praise from both British and Americans as a result of the campaign in North Africa after the former's first use of the tank at El Alamein. The chief complaint about the M4s was that there were not enough of them to go around. Some British and American units were forced to use the M3 because there were not enough M4s. The limitations of the M3 and its sponson-mounted gun had been realized when the tank was designed; combat experience further underlined this. The arrival of ever-increasing numbers of M4s in the combat zones during 1943 solved the most important complaint about the quality of American tanks.

Faith in the Sherman was based on a surprisingly limited amount of experience in tank vs. tank combat. There was only one major action between American and German tank formations in North Africa. The Germans had given the US Army an embarrassing lesson in modern warfare at the Kassarine Pass in February 1943. Although Sherman tanks were involved, US Army leaders attributed the defeat there, quite accurately, to lack of experience rather than to any fault in the tank.

The Sherman compared well with German tanks. The German Mark III was clearly inferior, but was withdrawn from all battlefronts during 1943. The German Mark IV had lately received a high-velocity 75-mm gun, superior to the one on the Sherman, but the latter was better protected. As the war progressed, the Germans piled a heavier armor on the Mark IV, but on balance—considering firepower, protection, and mobility—the Sherman was superior to the Mark IV. More ominously, the Germans introduced the Mark VIE, the Tiger I. This heavy tank, with its effective 88-mm gun, was later proclaimed the nemesis of American tanks, but it did poorly in North Africa. The British were able to stop it with small anti-tank guns and regarded it as a failure.[2] Moreover, battles with German tanks during the campaigns in Sicily and Italy later in 1943 did not shake confidence in the Sherman. In hindsight, the Tiger's ineffectual performance was due to poor tactics, terrain, and scarcity, not to its quality.

The next significant encounter with German tanks came at Gela, Sicily, in July 1943. Ninety Mark IIIs and Mark IVs of the Hermann Goering Division, supported by seventeen Tigers, at-

tacked the American forces landing there. With available anti-tank guns, tanks, and naval gunfire, the Americans dealt the Germans a resounding defeat. The Germans left forty-five destroyed tanks on the battlefield, ten of them Tigers.[3] Although naval gunfire and faulty German tactics both played key roles in the German defeat, there had been no convincing demonstration that American equipment was inferior. Although a contingent of the 2nd Armored Division lost an entire platoon to Tigers, the Americans also found their Shermans capable of dealing with the heavy German tanks. Encountering six Tigers moving down a road, one gunner, "knocked out three Tigers—ping, ping, ping."[4] One wounded officer, a veteran of Sicily, assured Ordnance officers in the United States that "he was mighty proud of his M4 tank."[5] Clearly, experiences with German tanks at Sicily had not discouraged American soldiers. Using existing weapons, GIs had beaten the best that the Germans had thrown at them.

A clash with German armor later that year was no more enlightening. When American forces landed at Salerno in September 1943, they were in the defensive sector of the 16th Panzer Division which immediately began piecemeal attacks. The 16th Panzer Division had more than 100 Mark IVs, and, although it achieved some success, it had only thirty-five tanks left by the end of the first day. Americans defeated the Germans with the same combination of weapons used at Gela, including naval gunfire.[6] Once again there was no convincing proof that American tanks were inadequate.

Allied officers heaped praise, not criticism, on the Sherman. Gen. Devers led a group of officers, including Gen. Barnes, who visited North Africa in December 1942 and January 1943. British generals told the Americans that "the M4 tank is a better tank than the best German tank."[7] American troops supported those appraisals. Gen. Devers concluded that "the M-4 medium tank (General Sherman) is the best tank on the battlefield."[8] The high opinion of the Sherman survived later battles in North Africa, as evidenced by the Chief of Ordnance's testimony to Congress: "They [Shermans] overcame every tank which they opposed."[9]

But Devers had no such praise for tank destroyers. He disagreed with the whole concept and disinterred the argument buried by Marshall in 1941:

> The separate tank destroyer arm is not a practical concept on the battlefield. Defensive anti-tank weapons are essen-

> tially artillery. Offensively, the weapon to beat a tank is a better tank. Sooner or later the issue between ground forces is settled in an armored battle—tank against tank. The concept of tank destroyer groups and brigades attempting to overcome equal numbers of hostile tanks is faulty unless the tank destroyers are actually better tanks than those of the enemy.[10]

Devers represented a significant body of opinion within the US Army. His view would become doctrine after World War II.

The tank destroyer units that participated in the first American land battle against the Germans in North Africa failed to test the concepts expressed in FM 18–5. Quite apart from the admitted inadequacies of improvised equipment, senior commanders failed to use tank destroyer doctrine. This continual misemployment made the performance of tank destroyer units unimpressive. In contrast, commanders came to believe that the British and Germans had discovered an antidote to tanks—concealed towed guns. This ultimately forced the Tank Destroyer Center to change doctrine, organization, and equipment. Tactical employment, not inferior weapons, was the main problem for tank destroyer units in North Africa.

The basic malady of the tank destroyer battalions deployed in North Africa was the continual failure of commanders to employ them according to the doctrine that had governed their training and equipment. Senior officers strongly criticized tank destroyer concepts during the campaign in Tunisia, but there is little evidence that they gave the concepts a fair test. Deficient tank destroyer equipment added to the criticism. Missions given to tank destroyer units were often far outside the scope of their equipment and training. The doctrine for tank destroyer units, as reflected in FM 18–5, was never employed in North Africa. Indeed, tank destroyer battalions were rarely employed as units. Tank destroyer companies, as a rule, were dispersed among larger units such as infantry regiments. The reconnaissance companies proved to be convenient for guarding the headquarters of corps commanders who seemed to be overly concerned with their own safety. The experiences of the first tank destroyer battalions to reach North Africa illustrate this point.

There were only two tank destroyer battalions, the 601st and the 701st, in action in North Africa until mid-February 1943.[11] The 601st was probably the first tank destroyer unit to suffer misemployment. Originally deployed to Great Britain, the 601st quickly lost its

reconnaissance company to guard the headquarters of II Corps, thus hampering the ability of the battalion to continue training. The 601st was subsequently sent to North Africa *without* its reconnaissance company. After arriving in North Africa, it was assigned to the British First Army which dispersed the battalion among subordinate units. By early 1943, an observer from AGF was able to locate one company of the 601st with an American task force and another company with Combat Command B (a regiment-size unit) of the 1st Armored Division. The observer was unable to locate the remainder of the battalion.[12]

A dispersed tank destroyer battalion could not fulfill the tank destroyer doctrine. Even if the 601st had been allowed to retain control of its tank destroyer companies, it would have been difficult to deploy those companies properly without its organic reconnaissance company. Proper reconnaissance was an imperative in FM 18–5. Breaking down the battalion into its tank destroyer companies made it totally impossible to use tank destroyer concepts.

The 701st was part of the initial landing forces in Africa. It, too, was to lose its reconnaissance company to guard a corps headquarters, and the remainder of the battalion was dispersed.[13] Later arrivals suffered the same fate. For example, the 805th was available at the Battle of Kassarine in February 1943 but "was split up into companies which were destroyed in detail.[14]

The tank destroyers faced other tactical problems as well. The missions assigned to the battalions or their detached companies rarely included the one mission that they were designed to accomplish, defense against tank penetration. Tank destroyer units received missions better suited to tanks, cavalry, or artillery. One observer reported a company of the 701st used as "attacking tanks and subsequently as supporting artillery."[15] Another witness affirmed that the 601st and 701st

> were generally used in roles for which they were not designed, such as infantry accompanying guns, assault artillery operating with tanks, and in cordon defense of areas, instead of in depth.[16]

The US Army official history notes that the 601st was used as a screening force at Kassarine Pass where the battalion was nearly overrun.[17] The narrative of the North African Campaign is replete with examples of misused tank destroyers.

One example, perhaps an extreme one, can be cited. B Company, 701st Tank Destroyer Battalion, with an attached reconnaissance platoon, operated as an independent unit during November 1942. It was ordered to attack the town of Gafsa, just after completing an overland march from Oran. The company, supported only by two antiquated French armored cars, managed to secure the town from scattered German infantry by using tank destroyers as tanks. Warned of approaching armor, the company commander, Capt. Gilbert A. Ellman, elected to meet the enemy at El Guettar where the terrain was more suitable for maneuver. B Company managed to destroy four tanks and drive off the enemy force.

Returning to Gafsa, the company was immediately directed to respond to an enemy attack at Sbeitla. Capt. Ellman recieved an order to "go up there and do something about it." Ellman surprised the enemy at Sbeitla, fixed him with fire from one platoon, and flanked him with another. The Italians retreated from the town after losing eleven tanks.[18]

B Company received missions far outside the intent of FM 18–5. Aggressive leadership, good tactics, and poor enemy performance enabled the unit to accomplish its missions. It should be noted that the reconnaissance platoon was instrumental to success in each of these actions. Elsewhere such offensive missions against a more determined enemy were less successful. As a witness of later actions commented:

> The tank destroyer is definitely a defensive weapon. Wherever destroyers have bulged out on their own and tried to fight German tanks they have been knocked out.[19]

Their equipment and doctrine made tank destroyer units defensive organizations. As one action in North Africa demonstrated, when employed properly, tank destroyers were effective at their intended task—destroying tanks.

During March 1943, the 1st Infantry Division was advancing into northern Tunisia near El Geuttar. The Germans dispatched the 10th Panzer Division to counter-attack.[20] Maj. Gen. Terry Allen, commander of the 1st Infantry, had ordered the 601st Tank Destroyer Battalion, finally assembled, to deploy into positions protecting the division artillery.[21]

Reconnaissance elements of the 601st, placed well forward, detected the German attack of some 100 tanks in the early, dark

hours of 23 March. Warned of the approaching armor, the 601st was able to adjust its positions which had been intended to oppose infantry. Two Tigers were among the thirty tanks knocked out by the 601st during the battle. Although the 601st lost twenty-one of thirty-one M3s, the German attack was repulsed.[22]

El Geuttar was almost a classic example of proper tank destroyer employment. Massing the battalion on excellent terrain enabled it to counter a German force that outnumbered the Americans three to one. The tactics of the battalion were excellent. It avoided both artillery and tank fire by shifting positions immediately prior to the battle, and its use of covered positions for firing kept losses from soaring higher.[23]

The only criticisms of the action emphasized the battalion's unnecessary exposure. There were no divisional units between the Tank Destroyers and the enemy, and the unit was too far forward. According to the prescribed doctrine, the tank destroyers should have been behind the division's artillery, where they could maneuver to counter the tanks. Being tied to the mission of protecting artillery restricted their ability to maneuver. Yet neither criticism outweighed the overall advantages of a massed tank destroyer battalion screened by its own reconnaissance. Unfortunately the tactics of El Geuttar were not used at Kassarine.

Despite success at El Geuttar, the tank destroyer concept did not prove itself in North Africa. Maj. Gen. George S. Patton refused to call El Geuttar a success, due to the battalion's high losses.[24] The failure of tank destroyermen to prove their doctrine to senior commanders was largely due to the failure of those same commanders to use the units properly. Several factors were probably involved in the misemployment of tank destroyer battalions.

One observer believed that the dispersal of tank destroyer units was due "to the necessity of holding a wide front with little means."[25] While there was some logic in spreading assets along a wide front, it would have been just as logical to keep the tank destroyers in reserve locations to react to German penetration on critical avenues.

Yet in defense of the dispersal of tank destroyers it must be pointed out that the American forces in North Africa did not face German tank attacks on a daily basis. Quite reasonably, generals were reluctant to leave an important asset sitting in reserve when it could be firing on the enemy. In this light, the failure of American commanders must be seen as their refusal or inability to concentrate

tank destroyers when a German tank attack was imminent or actually underway.

Contributing to the misuse of tank destroyers was the simple fact that many officers were unaware of tank destroyer doctrine. Gen. Bruce had recognized this problem, and the Tank Destroyer Center started conducting indoctrination courses for senior officers on 30 November 1942.[26] But many of the commanders who participated in the North African campaign had already departed from the United States. Personal study or the advice of tank destroyer officers would have been their only source of education. The sudden establishment of the tank destroyers in late 1941 had not allowed time to disseminate the radical new doctrine throughout a rapidly expanding army.

Furthermore, many commanders simply did not agree with the concept of tank destroyers. The US Army had not reached a doctrinal consensus concerning anti-tank warfare. Although the Anti-tank Conference of 1941 demonstrated that the bureaucracy was willing to accept the mobile tank destroyers, this consensus did not necessarily represent the views of the men who would command forces in the field. With the exception of Hodges, the chiefs of branches in 1941, generally an elderly lot, were never to command forces in combat during World War II. On the other hand, tank destroyer doctrine was sometimes misunderstood by those in the field, contributing further opposition to tank destroyers.

By 1943, Bruce was "distressed over the attitude of Gens. Patton, Devers, Bradley, and now Lucas [Maj. Gen. John P. Lucas]."[27] Gen. Patton's objection to tank destroyers was simple: they should have been tanks. He would have preferred to replace tank destroyers with more tank battalions. A good offense was always the best defense to Patton, and the tank destroyer was simply a poor tank. He believed that tanks could fill the need for mobile anti-tank guns while retaining the offensive capability of tanks.[28]

The views of Bradley and Lucas had a more direct impact on the tank destroyers, although their disagreement was less fundamental than those of Patton and Devers. They disagreed with self-propelled guns, although the idea of separate anti-tank battalions was acceptable. Gen. Bradley was undoubtedly impressed by the effectiveness of the Germans' dug-in anit-tank guns in North Africa. The readily concealed German guns were effective and difficult to pry from their positions. In January 1943, Bradley complained

about the high silhouette of the self-propelled tank destroyers. He stated his preference for towed guns that could be dug in with only their muzzles above the ground.[29]

The views of Gen. Lucas were even firmer than those of Bradley. After observing the Sicilian Campaign, Lucas commented:

> *The tank destroyer has, in my opinion, failed to prove its usefullness.* I make this statement not only because of the results of this campaign but also after study of the campaign in Tunisia. *I believe that the doctrine of an offensive weapon to "slug it out" with the tank is unsound.* I think that the only successful anti-tank weapon is one which has a purely defensive role, has high penetrating power and such a low silhouette that it can be concealed, dug in, and hidden by camouflage. . . . I am of the opinion that the anti-tank weapon should be a towed gun of great power and low silhouette.[30]

Lucas' report was influential in AGF. For example, while discussing a proposed rearmament of the M10, Brig. Gen. John M. Lentz, the G-3 of AGF, recommended informing the Ordnance Department that "the trend is toward towed guns (quote Seventh Army Report . . .)."[31]

Successful use of towed anti-tank guns by both Allied and Axis forces in North Africa put pressure on the United States to adopt those weapons. German tactical skill with anti-tank guns and the legendary "88" provided ample demonstration of the effectiveness of such weapons. British success with towed weapons was probably just as influential. Soon after the US Army's debacle at Kassarine, the British soundly defeated a German thrust at Medenine. British 6-pound anti-tank guns thwarted the German attack and destroyed over forty Panzers.[32] One American observer in North Africa said that it was "the best job of tank destroying that has occurred in Africa. . . ."[33]

The doctrine of the tank destroyers assumed that infantry units could protect themselves from tanks. This allowed the tank destroyers to remain in reserve, available to counter major penetrations. However, the ineffectiveness of the infantry's organic anti-tank gun, the 37-mm, meant that the foot soldiers could not protect themselves from tanks. Morale sank. This must have put great pressure on commanders to spread tank destroyer units among the

infantry units. Ironically, the failure of the only American towed anti-tank gun probably contributed to the pressure for improved guns and to the misuse of tank destroyers.

There was no shortage of criticism of the 37-mm gun. Col. Robert S. Miller, an observer from AGF, noted:

> Two general officers condemned this gun as useless as an anti-tank weapon and strongly recommended that it be discarded. They stated that it would not penetrate the turret or front of the German medium tank, that the projectiles bounced off like marbles, and the German tanks over-run the gun positions.[34]

The comment was typical. However, the same observer noted that the problems of the 37-mm gun were not all due to the gun's performance. Col. Miller discovered that infantry units were not placing the weapons in concealed positions where they could engage the vulnerable flanks of German tanks. Thus the 37-mm was forced to fight the frontal armor of German tanks—something that no one had ever claimed it could do. Miller, an infantryman, recommended that the gun be retained in infantry battalions while training should stress proper employment.[35] Furthermore, many units were using the wrong ammunition. Gen. Barnes, who accompanied Gen. Devers to North Africa, discovered that about half of the 37-mm ammunition was old, semi-armor-piercing (SAP) shot. He found that the men of the units could not tell the difference between SAP rounds and later, far superior ammunition, with an armor piercing cap. In addition, Barnes was unable to find any of the newest 37-mm ammunition in Africa—the M51 rounds that had increased velocity (from 2,600 fps to 2,900 fps), which made them even more potent.[36]

In an attempt to refurbish the image of the 37-mm, Ordnance officers tested the gun with M51 rounds against two captured German tanks. They found that the Mark III's front could be penetrated at 800 yards; its flanks were vulnerable at 1,000 yards. The Mark IV's front was penetrated at 400 yards and its flanks at 850 yards.[37] But tests could not change opinions cemented by experience on the battlefield. As another observer concluded, "Confidence in the 37-mm gun as an anti-tank gun has been lost."[38]

Dissatisfaction with the 37-mm gun led to a request from Gen. Eisenhower for the American version of the 6-pounder.[39] The 6-pounder, designated the 57-mm by the US Army, was in production

in the United States to meet British and Russian requirements and thus readily available.[40] Gen. McNair denied the wisdom of issuing the 57-mm because it was less mobile than the 37-mm.[41] Hoping to replace regimental anti-tank companies with a tank destroyer battalion equipped with 3-inch guns, he believed that 37-mm guns supplemented by bazookas would offer sufficient close-range protection for infantry battalions.[42] The War Department disagreed and the 57-mm anti-tank gun became standard equipment for infantry divisions.[45]

The 37-mm gun was no more successful in the tank destroyer units than it had been in infantry units. Indeed, the weaknesses of the 37-mm were accentuated when mounted in the Fargo, a 3/4-ton truck, because it was more vulnerable to enemy fire. As one observer concluded, "The sending of such a patently inadequate destroyer into combat can at best be termed a tragic mistake."[44]

Although far more successful than the Fargo, the M3 also received mixed reviews. One observer reported that the "heartiest possible praise was given to the 75-mm gun SP as an effective anti-tank, or tank destroying weapon."[45] On the other hand, Gen. Lucas condemned the M3 because of its vulnerability.[46]

Reports of the M3's immediate replacement, the M10, were more encouraging. Combat revealed that the M10 was clearly superior to the M3. The troops were satisfied with the new vehicle. Its increased firepower and greater cross-country mobility were the main sources for praise.[47] Heavier armor and 360-degree traverse for the main gun also built confidence in the vehicle, although it lacked the mobility to outrun medium tanks.

The effectiveness of their equipment proved to be the brightest aspect of the first experiences of the tank destroyer units in combat. With the exception of the Fargo, the guns of the tank destroyer battalions proved capable of destroying German tanks.

The tactical employment of tank destroyers presented a less happy picture for the new units. The tactical doctrine of the tank destroyers, although never given a fair test, was condemned nonetheless by important military figures such as Gens. Bradley and Devers. Success at El Guettar could not outweigh the lack of success at Kassarine and other places. In contrast, the experiences of the British and the effectiveness of German anti-tank weapons generated changes in tank destroyer doctrine, organization, and equipment.

4

Development and Changing Doctrine 1942-1943

During 1943 the US Army labored to translate the lessons of its first combat experiences into improved doctrine and equipment. Written doctrine had to be revised to incorporate combat experience. Thus, the demand for towed guns forced the Tank Destroyer Command to change its organizations to accept the new weapon. Adoption of towed guns also affected development since this weapon needed improvements to meet the Tank Destroyer Command's standards.

Developing better weapons continued to absorb a great deal of attention from the Tank Destroyer Command. The Command pressed on with the T70 and finally put that vehicle into production. The appearance of heavy German tanks such as the Tiger and Ferdinand persuaded AGF to produce a heavier anti-tank weapon, the 90mm gun. Technical problems slowed and complicated development efforts. Not surprisingly, it proved simpler to revise doctrine than to develop equipment.

Combat experience created pressure to revise tank destroyer doctrine. Significantly, the so-called "lessons" from the front were not solely those perceived by individuals within the Tank Destroyer Command. The officers at Fort Hood, for example, believed that tank destroyers suffered from misuse and their expedient equipment, not bad doctrine. However, the Command began revisions to modify its doctrine during the summer of 1943. As the Center's history indicates, "the revision of FM18–5 was undertaken to bring tank destroyer doctrine into conformity with the lessons of combat in Africa as interpreted by higher headquarters."[1]

The frequent attachment of tank destroyer battalions in North Africa to divisions or smaller units reflected the concerns of the new manual. The 1942 version allotted only five pages to the subject of

supporting divisions, but the 1944 edition devoted twenty-one pages, with diagrams, to the subject.[2] More significantly, the tank destroyers attached to infantry divisions assumed the role of protecting friendly infantry by repelling the enemy's initial attack rather than his breakthrough, something which had been avoided in 1942. Tank destroyer battalions belonging to the corps or army retained the mission of mobile defense. Now willing to confront the realities of tank destroyer employment, the officers at Fort Hood were forced to make other changes to their doctrine.

Tank destroyers in North Africa were often accused of chasing or hunting tanks. This was a false criticism as far as Gen. Bruce was concerned. He complained:

> I believe that many reports from higher headquarters about tank destroyers chasing tanks are based on the fact that one platoon of three guns did attempt to chase tanks, the lieutenant commanding admitting his error.[3]

Nonetheless, the new field manual emphasized that "Tank destroyers ambush hostile tanks, but do not charge nor chase them."[4] Further, the aggressive "fire and movement" tactics of the first manual almost disappeared in its revision.[5] But the most drastic changes in doctrine resulted from the inclusion of towed weapons, which were never in favor at Fort Hood. In respect to the new weapons, FM 18–5 outlined an appropriate doctrine for towed battalions.

In general, the employment of towed units was the same as that for self-propelled. The basic concept of mobile guns employed in mass remained the same. When towed battalions were specifically mentioned, it was usually to point out their limitations. For example, while self-propelled companies could withdraw under fire, FM 18–5 cautioned that "daylight withdrawals of towed units are likely to result in heavy casualties."[6] Towed guns were deemed superior for advanced positions. This was probably due to the fact that a towed gun, when dug-in, was less likely to be observed than a self-propelled weapon. Doctrine for towed units was based primarily on experience with such units at Fort Hood.[7]

The failure of the Cletrac had breathed new life into the towed 3-inch gun. On 22 August 1942, AGF directed the Tank Destroyer Center to restudy the matter of towed mounts. Towed guns, noted AGF, could be unloaded at places where docking facilities were too

limited to handle the 30-ton M10. With the demise of the Cletrac, the towed gun was the only alternative lighter than 30 tons that could provide a version of the desirable 3-inch gun. AGF pointed out that it contemplated organizing a number of towed battalions and therefore directed the Center to develop a tentative plan for a towed battalion.[8] Thus lack of a really good self-propelled gun, rather than combat experience, kept the towed 3-inch gun alive during 1942.

After studying the matter, Gen. Bruce remained opposed to towed battalions. He believed that a towed battalion needed 300 more men than a self-propelled unit which already had 800. He pointed out that a prime mover and gun required more shipping space than a self-propelled weapon. Instead of the towed gun, Bruce recommended adapting the M3 so that its 75-mm gun could be shipped separately from the half-track. The half-track and gun could then be reassembled and employed until facilities were available to land heavier tank destroyers.[9] Opinions from the field overruled Bruce.

Based on comments from North Africa, AGF directed the Command on 1 January 1943 to test a towed tank destroyer battalion. Personnel of the 801st Tank Destroyer Battalion conducted extensive field tests during January and February which resulted in a tentative organization on 12 March.[10] Maintaining momentum, AGF ordered fifteen self-propelled battalions converted to towed units on 31 March as a tentative measure for training. On 7 May, the War Department issued a table of organization for the towed battalion and officially authorized the new unit."[11]

The organization of the towed battalion was essentially the same as for the self-propelled unit. Elimination of one reconnaissance platoon and the inclusion of the remainder of those platoons in the headquarters company were the main adjustments. In addition, both the gun crews and the security sections were enlarged.[12] The lost reconnaissance platoon was probably the price that Bruce had to pay for the gun crews and security sections in order to keep the battalion down to a manageable size of about 850 men.

While the creation of a towed battalion was probably the most significant organizational change for tank destroyers, the measure had been preceded by other changes. As a result of the AGF decision during July 1942 to convert all units to 3-inch guns, the Tank Destroyer Command submitted a table of organization on 9 November 1942 that substituted another heavy gun platoon for the light gun

platoon in each company. The only battalions that employed the light platoons in combat were the first two units in North Africa.

On 12 November 1942, AGF directed the Tank Destroyer Command, along with all other commands subordinate to AGF, to reduce all organizations by 15 percent in personnel and 20 percent in motor transportation. The biggest cuts were made against administration and supply elements. The War Department's new tables, published on 27 January 1943, eliminated some tactical vehicles, including the anti-aircraft section.[13]

The Tank Destroyer Command was able to survive the adjustments to tables of organization which resulted from Gen. McNair's effort to economize on manpower, but the towed units remained controversial. A year after the War Department authorized such units, some officers still condemned them as worthless. But the Tank Destroyer Board later noted that preferences for self-propelled over towed guns stood at about eight to five. Since this was approximately the ratio of self-propelled to towed units furnished to the theaters by the summer of 1944, it seemed to justify both types of equipment.[14]

Gen. McNair resisted moves to have all tank destroyer units converted to towed guns. He believed that the combat experiences in North Africa had not settled the matter. Unless further experience justified a change, he remained convinced that both towed and self-propelled weapons should be supplied.[15] After McNair personally coordinated the matter with the Operations and Plans Division of the War Department, which had an obvious interest in the equipment of combat units, the latter agreed in November 1943 that half the battalions should be self-propelled and half towed.[16] The process of converting self-propelled battalions in the United States to towed guns was well under way by that time. An important part of that effort was devoted to the gun itself.

Faced with the reality of towed battalions, the Tank Destroyer Center began serious efforts to develop the 3-inch gun. The 3-inch gun had been standardized as the M1 in December 1941, prior to the completion of service tests.[17] Not surprisingly, service tests discovered many defects in the 3-inch gun. Although opposition to towed weapons from the Tank Destroyer Command had been the principal reason that the 3-inch gun was cancelled in the summer of 1942, SOS noted several deficiencies in the weapon and concluded that "in general, [the] carriage is not properly designed to accommodate the gun."[18] But the failure of the Cletrac convinced AGF to ask for

production of 500 3-inch guns on 23 August 1942.[19] Lack of participation of the Tank Destroyer Center in the development of the 3-inch gun up to that time is evident from the fact that no example of the gun was shipped to Fort Hood until 25 August 1942.[20]

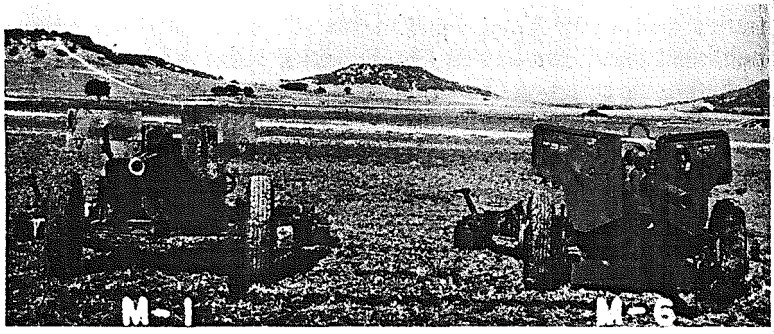


Fig. 8. The M1 and M6 towed 3-inch guns. Source: *TDC History*.

The deficiencies of the M1 proved to be curable. A new traversing mechanism cured one of the main problems of the prototype gun.[21] Field modifications eliminated other problems, primarily a poor sight and the tendency of the gun to jump when fired. The resulting weapon was standardized as the M1A1.[22]

Development work continued at Fort Hood through 1943. The Tank Destroyer Board went beyond correcting technical deficiencies and began adapting the gun to tank destroyer tactics. The M6 was standardized in November 1943.[23] The most visible change was a large, sloping gunshield, but other significant modifications were developed by the Tank Destroyer Board.[24] Finally, in February 1944, AGF was impressed enough to comment that "The redesign of the 3-inch Gun Carriage M1 into the 3-inch Gun Carriage M6 has resulted in an excellent towed tank destroyer weapon."[25]

One thousand M1 guns were manufactured before the M6 was perfected. In January 1944 AGF asked that all M1s be converted to M6s and requested 500 more M6s. The M1s had to be modified at the factory. Ultimately all units departing from the United States were equipped with the M6.[26] After having worked so hard on a weapon that they did not want, the men of the Tank Destroyer Command must have been cheered by progress with a weapon they did want, the T70.

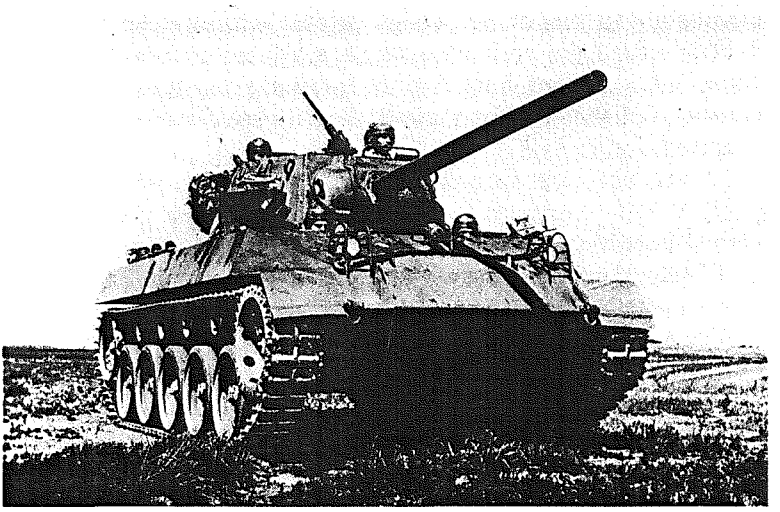


Fig. 9. The T70 after standardization as the M18 "Hellcat." Source: *TDC History*.

Shortly following the Palmer Board, the Ordnance Committee approved the development of the T70 on 4 January 1943 and approved the production of six pilot models.[27] Uncharacteristically, AGF requested production of 1,000 T70s only two days later. AGF rarely requested production of any major item of equipment before a prototype existed and preferred to wait until service tests were completed. Justifying its action, AGF commented:

> It is recognized that all of the modifications have not as yet been tested, however, the lack of a satisfactory tank destroyer gun motor carriage makes imperative the expediting of the production of the Gun Carriage, T-70.[28]

AGF was apparently trying to support Gen. Bruce, who continually complained about expedients and the lack of a suitable tank destroyer. But this swift decision led to a misunderstanding between AGF and Bruce.

The Tank Destroyer Center wanted to continue improving the design as studies progressed in order to build the best possible vehicle. On the other hand, AGF believed that the design should be frozen as quickly as possible in order to start production. As Gen. Moore commented in reaction to some changes proposed by the Tank Destroyer Center, "I think Bruce should be given emphatic

instructions to finalize the design of this vehicle at once." Gen. McNair settled the problem during a telephone conversation with Bruce, who assured him that the proposed changes were only inquiries and that any recommendations for modification would be coordinated with AGF.[29]

It was not surprising that a vehicle placed into production so hastily would require many changes. When the first pilot models reached Fort Hood there were serious problems. Most importantly, the T70 could not negotiate a 30-degree slope because the engine was underpowered and the torquematic transmission slipped excessively. Installing a more powerful engine and modifying the transmission allowed the 20-ton vehicle to meet minimum requirements.[30] Thus the T70, enthusiastically named Hellcat by the Tank Destroyer Center, went into production during the fall of 1943. Service tests then revealed a host of new problems, the most serious of which were an undependable starter and various weak points in the suspension. As testing revealed defects, the manufacturer applied modifications to vehicles still on the production lines.[31] The earliest vehicles grew increasingly obsolete as production continued and more and more modifications became necessary. By early 1944 the situation was chaotic. Over 1,000 T70s existed in varying states of modification.

To settle the matter, the Ordnance Department met on 5 February 1944 with representatives of the Ordnance Department, AGF, and the General Staff present. The meeting concluded that all vehicles below serial number 658 should be returned to the factory for modification. The rest would be modified in the field.[32] Then on 17 February 1944, the T70 was standardized as the M18. By this time, 1,200 had been produced; 1,097 of them required modification to meet the characteristics of the standard vehicle.[33]

Under these conditions, the development time of the Hellcat looked unusually good when viewed against the normal progress of other innovations. In just over two years, the M18 sped from conception to standardization. This record is better than that of any other armored fighting vehicle produced by the United States during World War II, and it may well be better than that of any other country. Rated at 50 mph, the Hellcat was the fastest tracked combat vehicle in any army. Moreover, it pioneered such important features as torsion bars and the torquematic transmission.[34] But the Hellcat's 76-mm gun would prove inadequate when the vehicle met

German tanks after D-Day. But by then the Tank Destroyer Command had been forced to develop a heavier weapon.

Ballistic characteristics made the 90-mm anti-aircraft gun a natural anti-tank weapon. The higher velocity and heavier projectile made the 90-mm gun a better anti-aircraft weapon than the 3-inch gun, and offered improved armor penetration. However, the 90-mm gun was only beginning to reach anti-aircraft units when the United States entered the war. Had the 90-mm gun been readily available, the 3-inch gun might never have been adapted for anti-tank use.

Ordnance officers initiated the development of the 90-mm anti-aircraft gun mounted on the M4 tank chassis in February 1942. Formally recognizing the project on 1 July 1942, the Ordnance Technical Committee recommended development of the vehicle, designated the T53, and noted that "reports from various sources have indicated the effectiveness of the German 88-mm aircraft (sic) gun when used as an anti-tank weapon.[35] Gen. Moore agreed with the idea. "It's time we got to thinking about our 90-mm to match this 88," he said to a tank destroyer officer. "It would be fine if we could get ahead of them [the Germans] just once."[36] The T53 appeared to offer a speedy way to produce a self-propelled, 90-mm gun since it used a maximum number of components already in production.

The decision to develop the T53 revealed a lack of analytical studies in the development process. Neither the Ordnance Technical Committee nor Moore mentioned any analysis, quantitative or otherwise, to justify developing the 90-mm gun as an anti-tank weapon. Such a study might have shown that the gun's edge in penetration over the 3-inch gun was needed to defeat some new or future German tank. But the reasoning seems to have been that, if the Germans have a big gun, then we should have one too.

In another effort to match the Germans, AGF directed the Anti-aircraft Command on 25 July 1942 to study the problem of firing the 90-mm gun against ground targets. Finding that an average crew needed five to ten minutes to emplace the gun with its single axle mount, the Anti-aircraft Board concluded that the 90-mm gun was "undesirable" for use against mechanized targets. The T2 gun mount then under development offered shorter emplacement times.[37]

Until the T2 was completed, the T53 appeared to be the only means available to use the 90-mm gun in an anti-tank role. The T53

was an M4 tank chassis with a shielded 90-mm gun perched on top, similar to the T24 carriage for the 3-inch gun. Its high silhouette certainly limited its tactical usefulness. At a conference on 24 August 1942, representatives of AGF, SOS, and the Ordnance Department agreed to produce 500 of the vehicles despite the problems.[38]

Gen. McNair had already pointed out the superiority of the 90-mm over the 3-inch gun. He wrote to Gen. Bruce in July that "there is a material advantage in the 90-mm so far as penetration is concerned. The trajectory seems a little flatter than that of the 3-inch."[39] Bruce quickly complained about production of the T53 before tests at Fort Hood, commenting that "The vehicle is an expedient and entirely lacks many of the major military characteristics considered essential by the TDC, in fact is a step backward rather than forward." AGF retorted: "It is the opinion of this Headquarters that the Tank Destroyer Board will find this gun mount an adequate anti-tank weapon."[40]

Despite these hasty AGF assurances, the members of the Tank Destroyer Board were quick to condemn the T53 after testing an example in the fall of 1942. AGF then agreed to cancel production of the T53, although they believed that development of a self-propelled mount for the 90-mm gun should continue. Anti-aircraft Board tests then convinced that organization that they had no use for the weapon either. But the project was not terminated until 12 April 1944. By that time there were much more promising projects for mounting the 90-mm gun.[41]

In the fall of 1942, Gen. Barnes asked his engineers to study a towed anti-tank carriage for the 90-mm gun.[42] Development of the weapon proceeded very slowly. The idea was not presented to the Ordnance Committee until 22 March 1943, when only a sketch of the proposed gun was available.[43] Formal approval of the project came on 29 April 1943.[44] AGF commented to the Tank Destroyer Command that "the studies are only in the first stages of development."[45]

The lack of progress was surprising. It was not a major development program, and AGF supported it. Ordnance sketches envisaged modifying the carriage and recoil system of the M2 105-mm howitzer to mount the 90-mm gun. This was the same approach that had delivered the M6 towed gun. Protection for the carriage would be provided by adapting the gunshield of the M6.[46] This apparently straightforward adaptation would prove to be very difficult for

Ordnance engineers and ultimately added fuel to the disputes between the Ordnance Department and AGF.

The demand from overseas for towed guns made AGF an interested participant in the perfection of such weapons. During October 1943, Gen. Moore called Gen. Barnes about the 90-mm towed mount and was assured that "we are pushing it."[47] On 2 November 1943, AGF had submitted its own statement of military characteristics for a towed 90-mm gun, which included a "blast deflector (muzzle brake)."[48] Responding, the Ordnance Department said that it would extend the T5 program to include the desires of AGF.[49]

The Ordnance Department had contracted with the Link-Belt Company to design the gun, immediately following the Ordnance Committee's approval of the project in April 1943. By November, the manufacturer was complaining that completion of the design was delayed because a subcontractor had failed to deliver gunshield designs.[50] The Ordnance Department caused more delay by ordering numerous design changes, including completely new trails.[51] Despite delays, Link-Belt managed to deliver a complete gun to Aberdeen in January 1944, promising to begin production during June.[52] Tests proved that Link-Belt had been too optimistic and development dragged on through 1944.

Meanwhile, the Ordnance Department had already begun work on a better self-propelled gun than the ungainly T53. The T53 used the standard anti-aircraft gun, but it was obvious that adaptation of the gun to fit the turrets of tanks or tank destroyers would be more advantageous. On 21 September 1942, Gen. Barnes directed his engineers to begin drawings for such an adaptation,[53] and the Ordnance Committee approved the project on 1 October.[54] Ordnance engineers accomplished the task of making the 90-mm gun suitable for vehicles by adapting it to fit the recoil system of the vehicle-mounted 3-inch gun. Rapidly accomplishing the necessary work, Ordnance engineers mounted the gun in an M10 tank destroyer and fired it by the end of December 1942.[55] Barnes then recommended that the modified M10 continue development as the T71.[56]

Objections to the T71 swiftly appeared. Gen. Bruce apparently viewed the vehicle as just another expedient, and one made worse by the fact that he had disliked the M10 from the start. But AGF had already shown an interest in the development of the 90-mm gun for

Fig. 10. The M10 and M36 in Germany, 1944. Source: US Army Photo.

anti-tank purposes. Compromising, AGF agreed to the T71 with the understanding that it was a development project intended only to secure information about the practicality of mounting the 90-mm gun on the M10. Fort Hood made its objections plain:

> The gun is not desired by the Tank Destroyers as a tank destroyer weapon since it is believed that the 3-inch gun has sufficient power. It is further felt that the Gun Motor Carriage, M-10, is too heavy and too slow.[57]

The project soon met delays. Tests of the original mount that ended in January 1943 proved that the vehicle was unsatisfactory, principally because of the basic faults of the M10. The 90-mm gun exaggerated the already unbalanced turret of the M10. Further, the heavier gun clearly required power traverse. Therefore Ordnance engineers had to start a complete development program for a new turret.[58] By May 1943, a wooden mock-up of the turret was completed in Detroit. In August, Colonel Joseph M. Colby, head of research and development at the Tank-Automotive Command, recommended that the T71 be standardized even though metal prototypes were still incomplete. A month later the prototype of the T71 finally arrived at Aberdeen.[59]

In September, after ASF rebuffed the Ordnance Department's first request for production of the T71, Gen. Barnes began cultivating support for the vehicle. He contacted members of the Armored Command and exhibited the vehicle to Gen. Moore of AGF.[60] Their favorable response encouraged Barnes to ask for production of from 500 to 1,000 T71's on 4 October 1943.[61] Brig. Gen. William F. Dean, who replaced Moore at the Requirements Section of AGF, thought that "Gen. Barnes's recommendation is considered to have considerable merit . . ." Besides a superior fighting compartment and power traverse, Gen. Dean mentioned that the T71 weighed 3,900 pounds less than the M10 since the redesigned turret eliminated the need for counterweights. The 90-mm was also better than the 3-inch gun for destroying both German tanks and pillboxes.[62]

The superiority of the 90-mm gun was not the main reason that Dean recommended producing 1,000 T71s. This course would also use excess M10 chassis already ordered or on hand and allow cutbacks in the production of the now unwanted M10s. Brig. Gen. John M. Lentz, AGF's G-3, agreed: "We have more M10s than we know what to do with."[63] By the fall of 1943, AGF found itself with far more tank destroyer weapons than it could use. This was primarily due to a reduction in the number of tank destroyer battalions. Gen. McNair had wanted over 200 of them in 1942, but the War Department only authorized 144. McNair recommended in April 1943 that the program be reduced to 106 battalions, since there was no great demand for tank destroyers from the theaters. By October 1943 the War Department planned to cut the number to sixty-four, but, after McNair objected, settled on seventy-eight battalions.[64] Meanwhile, production of M10s had continued because there was no alternative weapon. In October 1943, AGF found itself with existing or projected production of 11,547 self-propelled tank destroyers—enough for over 200 battalions—and a requirement for only 2,862.[65]

Based on the fact that "We are over-producing on TDs," Gen. Lentz did not recommend producing 1,000 T71s.

> The mobility of the T-70 precludes going to the T-71 unless the added power of the 90-mm gun is essential. It is not at this time. Conditions might change. A few heavily armed units might find employment against fixed defenses.

Despite his misgivings, Lentz concluded that ". . . possible future

developments of German armor, and the possible need for power against fortification . . . warrant construction of a moderate number (300) of T-71s."[66] Gen. McNair agreed but felt that they would not be amiss to raise the number to 500—enough for ten battalions and a reserve—while stopping production of M10s.[67] On 25 October, AGF requested ASF to produce 500 T71s and terminate M10 production.[68]

Despite the rapid approval of T71 production, the vehicle did not see action for nearly a year. Tests at Fort Knox revealed problems that demanded time-consuming modifications. The Tank Destroyer Board did not think that the modified T71 should "be considered suitable for use as a tank destroyer" until February 1944, and production of T71s did not begin until April.[69] In June, the T71 was standardized as the M36.[70] Besides being the first successful version of a 90-mm anti-tank carriage, the M36 had also helped bring the conflict between tanks and tank destroyers to the surface. ASF had refused the first request for production of the T71 in September 1943 because the Acting Chief of Ordnance, Maj. Gen. Thomas J. Hayes, had lumped the request with a proposal to produce the T25 and T26 tanks. The tanks were the reason for ASF's refusal, not the T71.

Development of the T20s continued rapidly during the last months of 1942, and controversy over the tanks had been boiling in 1943. By January 1943, the turret for the T23 was finished. General Electric Company completed the T23 during February and assembled the complete tank on 10 March. Five days later Barnes called Devers and invited him to see a demonstration of the T23 at General Electric's plant in Erie, Pennsylvania. Gen. Devers's praise of the tank on 20 March encouraged Barnes enough to consider requesting production of 300 tanks for a service test. Service tests did not require that many, but Barnes wanted 300 since that number would establish a production line and lead to mass production.[71] Only three days later, Gen. Campbell sent the request for 300 tanks to Gen. Somervell.[72] While waiting for Somervell's reply, Barnes arranged another "show" for his shiny new toy. Gens. Marshall, Somervell, and McNair attended the next demonstration at Erie, Pennsylvania, on 5 April.[73] Apparently getting opposition from neither Marshall nor McNair, Somervell approved production of 250 of the experimental tanks on 9 April.[74]

Meanwhile, other developments had led to further modification of the T20 program. In October 1942, Ordnance engineers discov-

ered that it might be possible to mount a 90-mm gun in equipment carrying the 3-inch gun. The discovery, which had led to the M36 tank destroyer, also concerned the T20 series since the 3-inch gun was being considered for those tanks as well. Barnes was interested in mounting the 90-mm in the T23 because he believed that Gen. Campbell would not be enthusiastic about the tank unless it carried the 90-mm gun.[75] On 24 April, Barnes proposed two versions of the T23 with the 90-mm gun to the Ordnance Technical Committee (OTC). The proposal designated the two new versions as the T25 and T26. The T25 would be a T23 with the 90-mm gun, which required a larger turret. The T26 would be a more heavily armored version of the T25.

The decision to build a more heavily armored tank revealed an interesting aspect of the thinking behind the American development process. The frontal armor of the T25 was increased from three to four inches to produce the T26. Justification for this thicker armor was "to provide an improved tank with armor equivalent or superior to the German Mark VI. . . ."[76] In hindsight, it would have been more logical to adopt thicker armor because this would protect the tank from German guns such as the 88-mm, an example of which had been in the United States since 1942.[77] But the OTC stood logic on its head and specified a thickness of armor that was intended to protect a German tank from Allied anti-tank guns.

Both the T25 and T26 would be produced from the 250 T23s already approved in the following quantities: 200 T23s, 40 T25s, and 10 T26s. The OTC approved the measure on 6 May, and Barnes forwarded the proposal to ASF that same day.[78] ASF obtained the War Department's approval on 24 May and so informed the Ordnance Department two days later.[79] Although no AGF representative signed the Ordnance Committee's minutes, ASF had obtained that headquarters concurrence.[80] During all this, work continued on the other tanks of the T20 series.

The T20 was complete on 10 May and running five days later. Its torsion bar sister, the T20E3, followed a month later. Ordnance had already shipped a T23 to Fort Knox on 18 April to begin testing. The T22 was less successful than the other tanks of the T20 series, and a prototype was not completed until 22 May.[81] Its transmission and auto-loading 75-mm gun proved to be very unreliable. Gen. Barnes never tried to place the T22 into mass production, though development work was not halted until February 1944.[82]

As testing of the T20 and T23 progressed during July 1943,

Barnes became convinced that these two tanks should be put into mass production. Believing that the M4 was rapidly becoming obsolete, Barnes advised Moore that standardization and production orders for 500 T20E3s and 500 T23E3s should be completed immediately to be sure that the tanks would be available by mid-1944. He wanted production orders for both types of tanks since the choice between the two different transmission systems was very uncertain. "We cannot, however, recommend," he admitted, "that we go into the torquematic [T20E3] or the electric [T23E3], as we do not know enough about it.[83] He planned to make a choice between the two transmissions after testing had indicated a clear preference. The production orders of the tank not selected could be applied to the preferred choice, raising the latter's production to 1,000. After his informal conference with Moore on 24 July, Barnes drafted an approval for the Ordnance Committee, but he did not send a formal request through Gen. Campbell and ASF.[84]

The resulting proposal for production of the T20 and T23 surfaced as a request from Maj. Gen. John K. Christmas, Chief of the Tank-Automotive Command at Detroit, Michigan, that circulated between ASF and AGF. Christmas informed the Chief of Ordnance on 20 July that engineering studies of the T25 and T26 demonstrated that the electric drive transmission planned for the two tanks was unacceptable since it increased their weights excessively. Therefore Christmas substituted torquematic transmissions and requested production of fifty more T23s—making a total of 250— to use the electric drive transmissions already ordered.[85] On 24 July, the Ordnance Department forwarded its recommendation to ASF, and the latter agency sent the document to AGF for their concurrence.[86] After smooth sailing, Barnes's proposals for development of the T20 soon ran into heavy weather.

There had been a drastic change in the tank development scene between the Ordnance Committee approval of the T23 and its variants and Barnes's proposal to produce 1,000 untested tanks. In mid-May, Gen. Devers left Fort Knox to take command of ETO after its commander had died in an airplane accident. While Devers commanded the Armored Force, AGF was not a major factor in tank development. As Devers put it, "AGF was out of the picture."[87] But after Devers departed, Gen. McNair swiftly took charge of the Armored Force and AGF became a suddenly full-fledged participant in tank development. Barnes's informal recommendation to produce

new tanks had probably been normal procedure with the Armored Force, but it was a whole new ballgame when McNair became a player.

AGF replied to Christmas's letter on 29 July and mentioned the informal request from Barnes for production of 500 T23E3s, noting that the request was under study by the Armored Command. Since the torquematic transmission had a definite weight advantage in the T25 and T26, officers in the Requirements Section could see no reason why it would not also have the same advantage in the T23. AGF's endorsement to Christmas's request commented: "Pending further study, it is not believed that additional electric drive T23E3s should be ordered until the torquematic drive tank has been thoroughly tested and a definite decision reached as to which type is most desirable." In addition to its non-concurrence, AGF acidly noted that Barnes and Christmas should coordinate their requests.[88]

Embarrassed by AGF's criticism of his subordinates' lack of coordination, Maj. Gen. Lucius D. Clay, ASF's Director of Materiel, got into the act. His reply of 31 July to the Ordnance Department noted: "It is desired that all actions leading to commitments of this nature or magnitude be referred to this office." Since AGF had refused to agree to Christmas's proposal, Clay turned down further production of the T23 beyond the 200 already ordered.[89]

Fig. 11. *Left to right:* M3, M10, M18 and M36. Source: *TDC History.*

But Barnes sent his draft copy of the proposed Ordnance Committee Item anyway. He strongly recommended that the production of the tanks T20E3 and T23E3 mentioned in the draft be approved.[90] By this time, however, the matter had already been

settled at a meeting between representatives of AGF, Armored Command, and the Ordnance Department.

On 11 August, the Chief of Ordnance met with Gen. Moore and Gen. Gillem, Commander at Fort Knox. AGF agreed to the production of fifty more T23s. The material had been ordered and some parts fabricated. But it did not desire to standardize any tanks of the T20 series without additional tests that would clearly demonstrate the advantages of those tanks over the M4. Gillem noted that the T23 was insufficiently tested and the Armored Board had had no opportunity to test the T20E3. But AGF did not oppose further development efforts: "Undoubtedly, if we can make better tanks, they should be placed in the battlefield as soon as practicable; hence, development and tests should be prosecuted at the greatest practicable speed."[91] AGF had consistently supported developmental efforts, but acquiescing to mass production of untried vehicles was another matter. The attitude of AGF was not surprising after the expensive and embarrassing lesson derived from hasty production of the M7. Undoubtedly, the events of March 1943 had made AGF more cautious in July.

By mid-1943, the stage was set for the development process as it would exist during the remainder of the war. The Tank Destroyer Center had finally selected its ideal weapon, the T70, and would spend the rest of the year perfecting it. Satisfaction with the T70 and Gen. Bruce's re-assignment marked the end of the disputes between the Center and Ordnance. Henceforth initiative for new tank destroyers shifted from Camp Hood to the War College. There Gen. McNair still believed that tank destroyers—not tanks—were the proper antidote to German tanks. This in turn affected tank development, since McNair now represented the users.

The T20 series became the focus of tank development. The failure of the M7 ended the Armored Force's only project to replace the Sherman. This left the T20s designed by Ordnance as the only alternative short of going back to the drawing board. There was no time to begin anew. Devers was apparently satisfied with the T23, but he had left for Great Britain in May.

5

Controversy and Development 1943

After May 1943, McNair's opinions concerning both tank and armor doctrine would prevail over those of the Armored Command. AGF had only been an observer and consultant before Devers departed the scene. After he left, AGF, not the Armored Command, represented the user's point of view in the developing process. This led to disputes between AGF and the Ordnance Department. Misunderstandings over a towed 90-mm gun for tank destroyer units made their relations even worse. But arguments about tanks dominated the scene. Gen. Barnes ultimately won with the aid of Devers and the British, and the T26 was put into mass production. The rejection of his proposal to build 1,000 untested tanks was, however, only the first of many rebuffs.

Subsequent tests clearly showed that AGF's decision in July 1943 to oppose production of the T20E3 and T23E3 was correct. By 2 August, Col. Colby called Barnes to complain about the effort to standardize the T20E3. Colby recommended emphasizing the T25 since "they cannot keep the transmissions running in the T20E3."[1] Ordnance engineers never did get the transmission running. To propel the T25 and T26, the engineers apparently adapted the successful torquematic transmission of the M18 tank destroyer which, fortunately, proved able to handle the greater torque of the tank's more powerful engine.[2] The T20E3 was subsequently dropped by the Ordnance Department, and none were produced, except for the prototype. Since production orders for the T23 were already approved, it enjoyed a longer career.

Most of AGF and Armored Command criticism of the T23 arose from the tank's electric drive transmission. The possibilities of the electric drive fascinated Ordnance officers. Electric drives were unusual in land vehicles, diesel-electric train locomotives being an

exception. The electric drive used a normal reciprocating engine to generate the electricity that powered two traction motors, one for each track. Using electricity gave the system an infinitely variable range of speeds without the necessity of shifting gears. Greater mobility was obtained by the availability of continuous power, avoiding situations such as one encounters trying to start a standard transmission from a standstill on a hill. The two electric motors could also turn the tracks in different directions at the same time. This allowed the tank to pivot within its own length, a capability beyond most mechanical transmissions of the day. In addition, the reciprocating engine could be run constantly at its most efficient speed since power changes were reflected by changing the engine's load, not its speed. The only theoretical problem posed by the electric drive was its extra weight when compared to other transmissions. This amounted to nearly two tons in the 35–ton T23.[3]

Despite the theoretical advantages mentioned above, Armored Command and AGF officers became increasingly less enthusiastic about the T23 as they observed it at Fort Knox. The extra weight of the electric drive badly overloaded the T23's suspension, which was the same as the Sherman's. Suspension problems were amplified because the electric drive concentrated weight at the rear of the vehicle. Furthermore, the electric drive was more difficult to repair than mechanical transmissions and totally unfamiliar to US Army mechanics. Adoption of the T23 would have made it necessary to train a large number of specially qualified mechanics and make sure they arrived at units equipped with the T23, all at a time when AGF was feverishly struggling to organize and train units for the forthcoming invasion of Europe. Then, after combat operations in northwestern Europe emphasized the necessity of close cooperation between tanks and infantry, the T23 presented still another problem. The tank could not be operated at speeds less than 10 mph without damaging the traction motors.[4] Easily the clearest tactical lesson learned by the US Army during World War II was that infantry and tanks must habitually work together, which remains doctrine in the 1980s. But the T23 would have made such cooperation extremely difficult. Developers of tanks in several countries tried and discarded the electric drive; no modern tanks employ it. As Col. George M. Dean of AGF's Requirements Section finally put it: "The AGF would not accept the electric drive until it proved itself in service

tests—it never did."[5] In 1943, however, the primary reason that AGF and the Armored Command opposed the T23 was that it had no convincing advantages over the Sherman.

The disputes over the T23 revealed the complexities of designing a major item of equipment. The tank was not simply a weapon; it was a weapons system. The men involved in tank development during World War II realized this, although they lacked the obfuscating jargon of systems analysis. A weapon might be defined as an item that has only one function. In the case of a cannon, for example, as soon as the user selected the projectile's size and the distance that it must be thrown, then the designer's problem became the relatively simple one of creating the most efficient design that satisfied the user's demand. In contrast, the tank incorporated different functions. As Gen. Harmon emphasized, tanks must blend "gunpower, maneuverability and armor protection."[6] These different features had to be compromised since an increase in one dictated a decrease in the others. Disagreements over how the different characteristics should be balanced were the root of the disputes over tank development during World War II. Because of its exploitation doctrine, AGF steadfastly emphasized maneuverability. The Armored Force agreed, although they shifted towards gunpower as the war progressed. The Ordnance Department shifted its emphasis from maneuverability to gunpower and armor during 1943, which resulted in a clash with AGF.

Equally important, AGF realized that the tank was only part of a total system. The Ordnance Department did not seem to appreciate this fact. Any tank, no matter how refined, depended on crews and mechanics trained by AGF, as well as spare parts supplied by ASF.[7] The problems of training men to operate and maintain a new tank, complicated by a different set of repair parts, served to diminish enthusiasm for the T23. Since the T23 had no convincing advantages over the Sherman, AGF was unwilling to shoulder its additional burdens.

Combat experience during 1943, as discussed in Chapter 3, had given no cause to doubt the efficiency of the Sherman. Even Gen. Campbell had supported the Sherman before Congress. The T23 provided no advantages that might have swayed AGF toward its adoption. Although it mounted the 76-mm gun, development efforts to mount that gun in the M4 reached fruition in August 1943. In

fact, the T23's greatest asset was that its turret provided the means to mount the 76-mm gun in the Sherman. Table 2 compares some basic characteristics of the two tanks:[8]

TABLE 2

	T23	M4A3 (76-mm gun)
Armament	76-mm gun (66 rds)	76-mm gun (71 rds)
Armor: hull front	3" @ 45°	2½" @ 47°
turret	3½" @ 0°	3½" @ 0°
Weight	75,311 lbs.	75,175 lbs.
Height	103"	110"
Ground pressure	15.5 psi	14.6 psi
Speed	35 mph	28 mph
Maximum grade ascending ability	60%	60%
Range	72 miles	84 miles

From Table 2 it is obvious that the T23 had little to offer over the M4. The T23's higher road speed meant little in combat since tanks had to slow down to fight, and its armor was only marginally thicker. Higher weight and ground pressure would have increased the problems American tankers had negotiating the mud found throughout Europe in late 1944. A lower silhouette was the T23's only unquestioned advantage, but this was not enough. Gen. McNair later summed up AGF objections:

> . . . the medium Tank T23 as now produced is unsatisfactory as a replacement in the substitute for the . . . M4 series. . . . The principal shortcomings of the M4 . . . can be attributed to the high unit ground pressure and difficulties with the suspension system. . . . This same suspension system is now used on the T23 . . . and its defects are further accentuated by the increased weight of the new tank. It is believed that the proposed torsion bar suspension . . . will provide a satisfactory solution . . . however, the overall tank width is increased to 134 inches, which is . . . incompatible with the requirements of standard army bridges, rail transportation and unloading of ships. The Medium Tank T23 then becomes a special type vehicle with greatly reduced tactical and strategic mobility and as such is not capable of replacing the M4. . . . Inasmuch as the present standard production M4 . . . is considered satisfactory for combat, it is believed preferable to delay the introduction of a replacement tank until one can be

Fig. 12. The M4 (76-mm) plows through French mud, 1944. Source: US Army Photo.

> produced which corrects the principal known deficiencies now existing and that embodies all the features that have been found desirable for this type combat vehicle.[9]

Before the dust settled from the dispute over the Ordnance Department proposal of July, the Armored Command had begun preparing its own recommendations for future tanks.

The Armored Command was interested in re-arming the Sherman tank with bigger guns. Gen. Devers had agreed to production of twelve M4s armed with the 76-mm gun in 1942, drastically reducing the Ordnance Department's enthusiastic proposal for 1,000 of those vehicles. The Armored Command tested the resulting vehicles in the spring of 1943 and found them to be unsatisfactory. This first attempt to re-arm the Sherman mounted the 76-mm gun in the standard turret, and the tankers believed that it was too cramped and unbalanced. Fortunately, the T23's turret was a satisfactory mount

Fig. 13. The M4A3E8 in Germany, 1945. This is the Sherman in its final form, "Easy Eight," which includes horizontal volute spring suspension (HVSS), and 23-inch, center-guide tracks. Source: US Army Photo.

for the gun and could be easily adapted to the Sherman. With the T23's turret, the M4 (76-mm) was a success. By this time the Ordnance Department's enthusiasm for a re-armed Sherman, so evident in 1942, had waned, possibly because it would compete with the T23. Gen. Barnes advised Colby to "get ourselves on record as being opposed to the switch."[10] Nevertheless Maj. Gen. Alvan C. Gillem, Devers's replacement, requested production of the new Sherman on 1 September 1943.[11]

Gen. Gillem's request of 1 September was intended to insure that tank armament remained suitable for armored doctrine. He had realized that the 76-mm gun was less useful for tanks, despite its ability to penetrate more armor than the 75-mm gun. Believing that high explosive capability was more important than armor penetration, Gillem's letter represented a retreat from an earlier proposal by the Armored Command that all Sherman production should consist

of versions with the 76-mm gun. Gillem's original recommendation of 21 August gained approval from AGF, and ASF directed Gen. Campbell to terminate the production of Shermans with the 75-mm gun during December 1943 and January 1944.[12] By 1 September several factors caused Gillem to modify his recommendation. The 76-mm gun was superior to the 75-mm gun only in its ability to penetrate about one-inch-thicker armor than the 75-mm gun. Other factors weighed heavily against the bigger gun. The larger size of 76-mm rounds reduced the amount of ammunition that could be carried in the Sherman. Despite the smaller size of the 75-mm round, its high-explosive projectile carried almost twice as much explosive filler as the 76-mm projectile. Finally, the 76-mm gun had tremendous muzzle blast, which blinded gunners with a cloud of smoke, and its ballistic characteristics were deemed less suitable for general use than that of the 75-mm. All of the problems of the 76-mm gun convinced Gillem that only a portion of American tanks should carry the new gun. A mix of differently armed tanks would increase the ability of tank units to deal with enemy tanks while preserving their capability to engage other targets. Without specifying numbers, Gillem recommended that production schedules of the Sherman be adjusted so that ultimately a third of the tanks in American armor units would have the 76-mm gun.[13]

Gillem's request sailed swiftly through AGF and ASF. By 6 September the letter was endorsed by AGF, and only three days later ASF forwarded the Armored Command's recommendation to the Ordnance Department.[14] Apparently pleased by the success of the Armored Command's proposal to increase the armament of tanks, the Ordnance Department decided to use the request as a vehicle for their tank projects. Agreeing with Gillem about the proper proportions for arming the Sherman, Maj. Gen. Thomas J. Hayes, Acting Chief of Ordnance, also recommended large production orders for the T20 tanks and T71 tank destroyers. He asked for 500 additional T23 tanks to get "continuity of production." In addition, Hayes recommended that "the present orders of forty T25 and ten T26 be increased by 500 each," in order to get those tanks on the battlefield in quantity during 1944.[15] ASF rejected Hayes's request for further T20 production, although it accepted his plans to build 3,250 Shermans with the 76-mm gun. Production of the T71 was felled by the same axe. Basing its position on previous AGF opposition toward production of the T20 series, ASF commented; "The procurements recommended by the Chief of Ordnance [for T23, T25, and T26]

. . . have been considered in separate actions and disapproved with the concurrence of the Commanding General, AGF."[16]

An official history of the Ordnance Department later implied that the T20 series was ready for production at the time of Hayes's request of 13 September and only delayed by opposition from AGF and ASF.[17] This implication is false. Objections of the Armored Command and AGF to the T23 continued to increase as tests proceeded at Fort Knox. To those agencies the T23 was no more ready for production in September than it had been in July. The T25 and T26 existed only on paper. Although the T25 was further along than the T26, drafting work for the former tank was only 50 percent complete on 10 September.[18] There is absolutely no evidence that AGF did anything to slow the design efforts of the T25 or T26. In view of previous experience with ordering untested vehicles and the continuing commitment to tank destroyers, AGF's opposition to the 90-mm gunned tanks was not surprising.

Further, the opinion of the official history is not supported by experience with other tanks. The T24 light tank provides an interesting parallel to the T26. Like the T26, the T24 represented a radical departure from previous American light tanks. The T24 also used torsion bars, torquematic transmission, and the box hull. However, the light tank was a far easier proposition to design and produce than the T26 since the former could use components directly transferred from the T70 tank destroyer which had been under development for some time. Satisfaction with the T70 and the promise of the T24 led to a production order for 1,000 light tanks on 21 September 1943.[19] Despite this early production order, the T24 (standardized as M24) did not begin dribbling into ETO until 1945.[20] It seems that early production orders do not necessarily translate into an effective tank's rapid arrival at the front.

When Hayes made his recommendation to produce tanks with 90-mm guns, McNair already had a similar proposal from Gillem on his desk. Gen. Gillem proposed to mount the 90-mm gun in the M4 by designing a new turret. He argued that combat experience had proven that American tanks sometimes had to engage German tanks in order to carry out their primary mission, and the Germans were introducing tanks with increasingly heavy armor. The 90-mm gun was needed in order to defeat those tanks, and the only way to get that gun into a tank by June 1944 was to mount it in a Sherman.[21]

But McNair refused Gillem's request. He argued that combat experience had shown that tanks should not engage other tanks and that no theater had requested tanks with 90-mm guns. Still retaining his faith in tank destroyers, McNair believed that enemy armor should be the target of our own anti-tank guns. In addition, the Ordnance Department had convinced McNair that Gillem's idea would result in a heavy tank.[22] When the Armored Command contacted Gen. Barnes, he replied that the Ordnance Department did not agree with the idea since it would create an "unbalanced design."[23] He did not explain his objections in detail, but Gillem's proposal was an obvious rival to the T25 and T26. Although Gillem estimated that a new turret would only increase the Sherman's weight by 4,000 pounds, Ordnance officers advised AGF that the increase would be 9,200 pounds. Their data helped to convince McNair that Gillem's idea was a poor one. Many officers at Fort Knox believed that Gillem should have gone to Marshall with the idea, but Gillem, torn between desire for the tank and loyalty to his commander, elected not to go over McNair's head.[24] This marked the end of an idea that promised to provide a 90-mm tank gun to American troops during 1944.

Though the Sherman with a 90-mm was never produced, it may be helpful to consider its feasibility. From hindsight, there were possibly two solutions to the problem. First, the T25 turret could have been mounted in the M4. This was possible because the turret rings of the M4 and T20 series were both 69 inches, and the T23 and T25 turrets were interchangeable. Such a solution was finally tried and proved feasible in mid-1944, but by then it was too late.[25] The T25 turret turned out to weigh approximately 4,000 pounds more than that of the T23. The Ordnance Department's 1943 estimates had been erroneous.[26] This extra 4,000 pounds would have raised the M4's weight to 37 tons, hampering its mobility. But a 42–ton version of the Sherman (the heavily armored "Jumbo") was successfully employed in Europe so the extra weight would not seem to have been disastrous. Further, a Sherman with the T25 turret could probably have been available in 1944. Adapting the T23 turret began in July 1943, and the M4 (76-mm) entered production only seven months later. Since the T25 turret was complete in January 1944, it seems reasonable that Shermans with that turret could have been in production by September. Production experience with the M4 (76-

mm) indicated that a 90-mm version could have been rapidly produced in large numbers. These tanks could probably have been available in Europe in time for the Battle of the Bulge.

The second solution might well have been quicker. The turret of the M36 could have been mounted in an M4 chassis and the vehicle issued to tankers. Such vehicles were constructed in 1944, when the US Army ran short of standard M36 chassis, and standardized as the M36B1. Tankers probably would have demanded an armored top for the M36's open turret, but this could have been improvised. The front of the M36 turret was only 1/2-inch thinner than the turrets of late production M4s. The sides were just 3/4-inch thinner. These vehicles could have been available as soon as production of the M36 started in April 1944. Thus they could have reached the field in the summer of 1944, possibly by D-Day. Of course the M36B1 would have been an improvisation and not totally satisfactory to the Armored Command. It carried too little ammunition and lacked a machine gun mounted coaxially with the 90-mm gun. Still, such a vehicle might have put a tank with the 90-mm gun into the hands of American troops in 1944, answering the main criticism of the Sherman. But the Armored Command and the Ordnance Department resisted improvised weapons until it was too late.

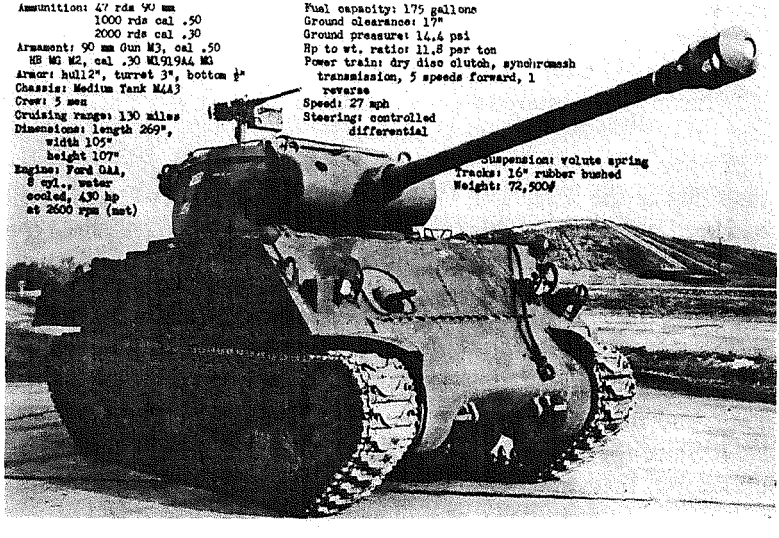
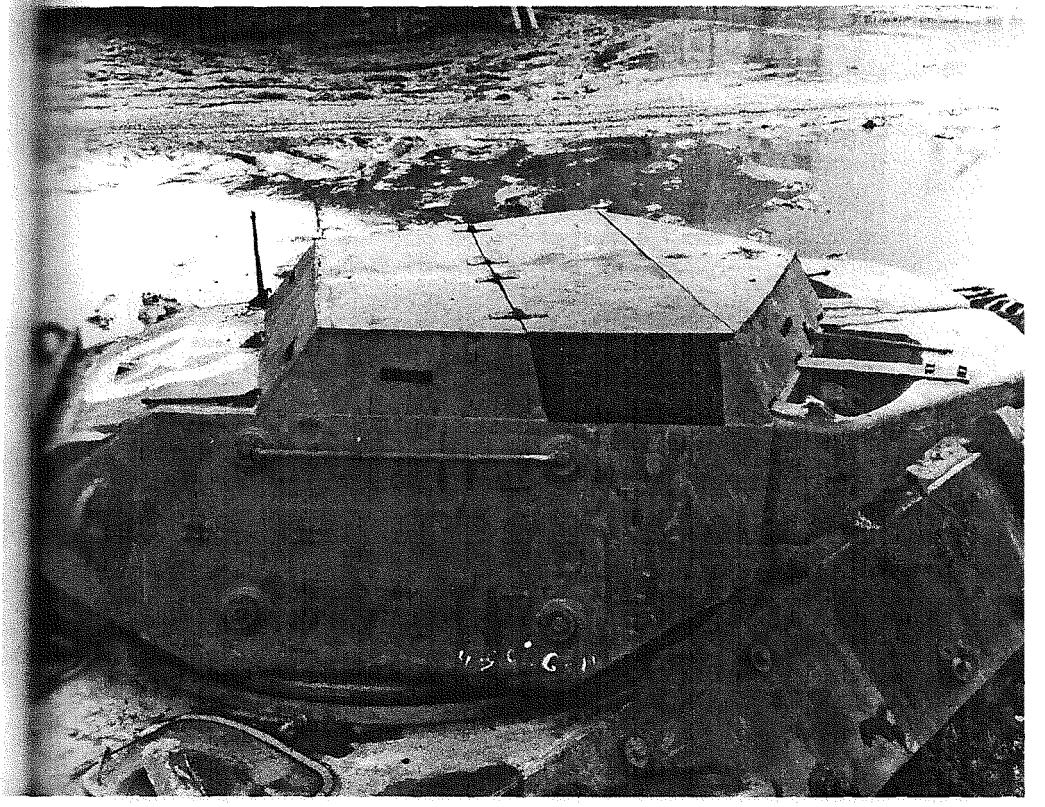


Fig. 14. The M36B1. Source: *M36 History*.

Meanwhile, the British had improvised a more heavily armed Sherman and were very happy with it. British designers had managed to mount their excellent 17-pounder (76-mm) anti-tank gun in the M4's turret. The 17-pounder's ability to penetrate armor during tests slightly exceeded that of the 90-mm gun. The tank was then hastily produced, named the Firefly, and deployed in British armor units prior to D-Day. The British offered the design to the US Army, but the Ordnance Department disregarded it as a "nuisance."[27] After seeing the vehicle in January 1944, Barnes commented to Colby that ". . . the position of the sight is terrible and the radio is on the outside." (The radio was placed in an armored box on the rear of the turret to save space in the tank and help counterbalance the long gun barrel.)[28] Later, Ordnance officers commented that it would be a "retrogression" to adopt the 17-pounder. Furthermore, it would require two years for the United States to produce ammunition, since Great Britain could only provide enough for

Fig. 15. The M10 with an armored top improvised in France, 1945. Source: US Army Photo.



herself. Undaunted by the disdainful attitude of American Ordnance officers, the British remained quite happy with the Firefly. The tank was, indeed, a less than perfect compromise. Its fighting compartment was so cramped that the assistant driver/bow gunner had to be eliminated to provide sufficient stowage for ammunition. Despite its faults, the Firefly remained the best tank-destroying tank in either the British or American armies until the first T26s appeared in 1945.

Gen. Gillem's request for production of the 90-mm gunned Sherman exposes the main reason that neither the Ordnance Department nor Armored Force felt compelled to accept any hasty improvisations in 1943. According to Gillem's figures, the 76-mm gun could penetrate the front of the German Tiger at a range of 2,000 yards.[30] The 90-mm gun's purported ability to do the same thing from 3,000 yards could not have been a very convincing argument to sway McNair toward the heavier gun, since the gunsights of the day made hits at such a long range very unlikely. Gillem's figures, provided by the Ordnance Department, were fantastically optimistic. Americans in combat found that the 76-mm and 3-inch guns might penetrate a Tiger at 50 yards, but were both considered to be generally ineffective against the frontal armor of the Tiger.[31] This misconception also explains why the men of the Tank Destroyer Command were so unenthusiastic about the M36. They considered the Hellcat's 76-mm gun to be fully adequate for dealing with German tanks. With disastrous effects, they invested confidence in the 76-mm gun until mid-1944.

Throughout the war the Ordnance Department fired its guns against nearly vertical plates of armor to establish their penetration capabilities.[32] The hardness of the test plate did not match that of German armor. More importantly, the Ordnance Department accounted for angled armor by geometrically calculating the increased effective thickness of the angled plate. Then, extrapolating a gun's penetration capability based on performance against the vertical plates, they calculated its capability against slanted armor. This technique failed to account for the tendency of projectiles to ricochet from angled armor. For example, the horizontal thickness of a plate of vertical steel is doubled when the plate is slanted 60 degrees, but its resistance to penetration is tripled because of ricochet.[33] This problem was not revealed in 1943. Displaying another failure of technical intelligence, Gillem's letter fails to mention the Panther, although it had appeared in battle at Kursk in July 1943. The only

two German tanks mentioned by Gillem were the Tiger and the Ferdinand. Tigers were never very numerous and the Ferdinand was only a means of using ninety vehicles that Dr. Ferdinand Porsche had designed to compete with the Tiger. The Panther was to become Germany's most important tank and a tougher foe than the Tiger. By November a memo to McNair from Maj. Gen. William F. Dean, who replaced Moore, demonstrated that the US Army had accurate knowledge of the Panther's characteristics, although Dean believed that the German production would emphasize Tigers.[34] Yet there is no evidence that anyone in AGF wondered whether their guns were adequate to cope with the Panther.

Technical intelligence was the responsibility of the Ordnance Department, and that agency clearly failed to measure American guns against the enemy's most dangerous tank. American guns were overestimated; the Panther ignored. The misunderstanding about the production of Tigers and Panthers was corrected prior to D-Day, but the weakness of American guns was revealed until they met the Germans. This was possibly the Ordnance Department's most serious failure during World War II. The fault lay in the evaluation of available information. Dean's memo shows that adequate data had arrived in time to warn American developers. But developers trusted the Ordnance Department's technicians, and the error remained hidden. Had the problem been realized before the summer of 1944, developers could have pressed for cures, and many improvements might have been possible. For example, Gillem mentioned hastily mounting the powerful 105-mm gun on a tracked vehicle then in production, but there was no enthusiasm for such a project. In 1943 developers still labored in ignorance.

After helping to put an end to Gillem's idea for re-arming the Sherman with the 90-mm gun, Barnes continued to try to get the heavy gun in a tank. Apparently Barnes anticipated ASF's refusal of the proposal to produce the T25 and T26. Barnes had started to open other channels for production orders for the T20 series even before Hayes's recommendation on 13 September. On 4 September Barnes was visited by Gen. Alexander H. Gatehouse, a British commander famed for his experiences in the desert. Gen. Gatehouse was very interested in obtaining heavily armored vehicles for use in Europe. Although Gatehouse was primarily interested in the T14, an experimental heavy tank being built for the British that never reached production, Barnes used the opportunity to sell the T26. He

told Gatehouse that the T26 was considerably better and assured him that it would be "out" in September or October. Barnes's assurances on that point were certainly questionable. Even more dubious was Barnes's boast to Gatehouse that "the T26 had been thoroughly tested and when it comes out, it will be foolproof." Though he did not have even a prototype of the tank that he was trying to sell, Barnes suggested that the British order 1000 T26s since "perhaps it will suffice to wake our people up." Disgusted with British efforts to produce suitable tanks, Gatehouse complained that "We can do nothing," and agreed to act on Barnes's suggestion.[35]

The British remained interested in the T26 through the fall of 1943. Several British officers visited Barnes. On 17 October Gen. John F. Evetts, Assistant Chief of the Imperial General Staff, told Barnes that the 90-mm gun was a "must" for battle on the continent. Barnes's confidence in the efficacy of British influence is apparent in the records of his office: "He [Gen. Evetts] and Gen. Richardson have a great deal of influence in England and may be able to help us in selling the 90-mm guns."[36]

Meanwhile, the War Department solicited the views of American fighting men. On 14 October, the G-4 of the War Department cabled all of the theaters to obtain their views on the types of tanks desired during 1944. The cable included descriptions of tanks under development. During the remainder of October and the first part of November, the theaters sent their responses to the War Department. The South Pacific and Southwest Pacific Areas disagreed about the desirability of medium or light tanks, but neither mentioned the T20 series. Responding on 21 October, ETO desired either the T20, T22, or T23,—"if the Armored Command accepts it after performance and gunnery tests"—and recommended further development of the T25 and T26.[37] However, Gen. Eisenhower, then commanding the North African Theater of Operations (NATO), preferred the "T23 medium tank . . . as the T25 and T26 are considered too heavy." Despite favoring the T23, Eisenhower noted that "the present mechanical transmission has been satisfactory and if replaced by an electric drive it must be equally reliable and easily maintained . . ."[38] His letter to ASF gave further emphasis to preferences in NATO. Enclosing comments from the 1st and 2nd Armored Divisions, the only American armored divisions with combat experience, NATO commented:

> Of the three medium tanks described in OCM Item 20342, the T23 with the 76-mm gun is by far the most desirable. This is the general opinion expressed by armored force personnel in the theater. The high muzzle velocity of the 76-mm gun will provide the greater fire power desired in the medium tank without increasing the weight and decreasing the ammunition storage to the extent necessary if the 90-mm gun is used. The T26 tank is not favored because it is not believed that the proposed increased armor protection over that of the present M4 series of medium tanks is justified by the corresponding increase in weight and decrease in maneuverability.
>
> The proposed electric drive is favored . . . [but] . . . It will be noted from the enclosures that the electric drive is viewed with some skepticism . . . [due to] . . . fear of additional and unusual maintenance problems from a new type of equipment. . . . If the electric drive is adopted, it must be equally as reliable as the mechanical transmission.[39]

Gen. Eisenhower's recommendation was an attempt to reconcile varied opinions about new tanks.

The men in the two armored divisions had no common view about new tanks. Maj. Gen. Hugh J. Gaffey, commanding the 2nd Armored Division, wanted the T23 with a 75-mm gun and no electric drive. His tank battalion commanders disagreed with each other; one desired the T25, two others argued for the T23.[40]

Opinion was similarly divided in Maj. Gen. Ernest N. Harmon's 1st Armored Division. Gen. Harmon leaned toward the T23. He admitted that heavier tanks might be useful, but not in armored divisions. Harmon's statement that the 76-mm gun was preferred over the 90-mm "if the 76 can do the job" shows that ignorance of the performance of American guns against German tanks was not confined to the United States. The commander of one of Harmon's tank regiments preferred the T25, but the other regimental commander, Col. Hamilton H. Howze (who went on to earn four stars and fame as the developer of the airmobile concept used in Vietnam) favored the T23. Howze asserted that "the T-25 and T-26 are not worth the trouble to build." Only the executive officer of the

maintenance battalion thought that the T26 was any good.[41] Clearly, battle experience had not produced a consensus concerning the best type of tank. Despite the lack of American support for the T26, however, this tank would be the one to enter production.

Gen. Barnes's cultivation of British support for the T26 bore fruit in November. On 13 November 1943, Gen. Devers, then Commander of ETO, cabled the War Department asking that the T26 be given the highest priority and that 250 should be produced to meet his requirements. His comment that the British War Office was going to ask for 500 of the tanks reflects British influence on his decision.[42]

Besides the negative attitude of NATO toward the T26, the request from Devers for production of the tank quickly raised arguments from Gen. McNair. In McNair's mind, he had already made a suitable response to the threat of heavier German tanks by providing for more heavily gunned tank destroyers. He had already approved the production of the T71 and a towed 90-mm gun was under development. Hence, McNair was in no mood to allow production of the T26. McNair's Requirements Section advised him of Devers's request, remarking that it

> intensifies the pressure upon AGF to immediately commit ourselves to the early production of a thick-skinned tank carrying the 90-mm gun. The British and the Ordnance have been convinced for some time that we should initiate such procurement without further delay.[43]

Gen. Dean recommended that AGF go on record against procuring the T26 until the pilot models had completed their service tests. Agreeing with Dean's recommendations, McNair commented:

> I see no reason to alter our previous stand . . . essentially that we should defeat Germany by use of the M4 series of medium tanks. There has been no factual development overseas, so far as I know, to challenge the superiority of the M4. An increase in armor or gun power can have no purpose other than to engage in tank vs. tank action—which is unsound. Moreover, such a tank would be disadvantageous in carrying out the primary mission of armor—to defeat those elements of the enemy which are vulnerable to tanks. The answer to heavy tanks is the tank destroyer, a

> 90-mm version of which we are producing to the extent of 500.[44]

McNair quickly made his views known within the US Army. Commenting to Gen. Marshall on the responses from the theaters about new tanks, McNair emphasized that "medium-heavy tanks T25 and T26 are recommended for development only. No pilot of either model has yet been completed."[45] Only two days after that message, McNair again emphasized his opposition to the T26 in a memo to Marshall concerning Devers's request. McNair pointed out that ". . . other than this particular request—which represents the British view—there has been no call from any theater for a 90-mm tank gun."[46] And he reminded Marshall of his philosophy of tank and anti-tank warfare:

> There can be no basis for the T26 tank other than the conception of a tank versus tank duel—which is believed unsound and unnecessary. Both British and American battle experience has demonstrated that the anti-tank gun in suitable numbers and disposed properly is the master of the tank. Any attempt to armor and gun tanks so as to outmatch anti-tank guns is foredoomed to failure. The primary mission of tanks is the destruction of those hostile elements which are vulnerable to them—not anti-tank guns.
>
> There has been no indication that the 76-mm anti-tank gun is inadequate against the German Mark VI tank. . . . Tank destroyers of either 76-mm or 90-mm caliber thus can support an armored division or other unit in whatever degree is necessary to protect them against hostile tanks, leaving the friendly tanks themselves free for their proper mission. Certainly the T26 tank, weighing upwards of 43 tons, is not well adapted to the primary mission of tanks.[47]

Faced with vehement opposition to Devers's request from one of Marshall's most trusted commanders, ASF acted quickly to resolve the dispute.

To do so, ASF sought help from the War Department. Besides the disagreement between ETO and NATO, Maj. Gen. Joseph T. McNarney, Deputy Chief of Staff of the US Army, had stated that

development efforts that would exceed the Army Regulation 850–15 limitations of 124 inches in width and 35 tons gross weight should be resisted. Gen. Clay advised the War Department that the T26 would exceed both limitations and could not cross the standard Bailey bridge. In addition, two vehicles with high firepower, the T71 and M4 (105-mm), were now on order and both vehicles could use bridges available to armored units. In light of the divergent views, Clay asked that ASF be given further guidance.[48]

Gen. McNarney queried Devers in December, mentioning that development was still progressing on the T26 and that the T71 with a 90-mm gun had already been ordered. Finally, McNarney asked Devers: "Is [your] request for 250 T26 tanks based on an operational requirement foreseen in your theater making it desirable to place [an] additional order prior to completion of service tests?"[49]

Even before Devers could answer, Barnes had seized another opportunity to advocate production of the T20 series. His proposal came as an endorsement to ASF's request for comments on the theaters' responses to the earlier War Department queries about new tanks.[50] In his letter to ASF, Barnes claimed that the T23 had proven itself successful and praised the tank profusely. He said that the T25 and T26 should be produced to ". . . have available tanks of greater firepower and greater armor protection, should they be required."[51] Barnes closed his letter with a recommendation for immediate orders for 500 additional T23s, 500 T26s, and 500 T25s. ASF forwarded Barnes's proposal to the War Department after directing the Ordnance Department to expedite production and tests of the T25s and T26s already ordered.[52]

Devers responded to McNarney's query before Barnes's proposal reached the War Department. Devers affirmed his request on 10 December, commenting that he foresaw a "definite need" for the T26 in his theater. He said that the T26 should be given equal priority with the T71. Closing his cable, Devers recommended that ". . . at least 250 T26 tanks be produced now."[53]

The issue was soon settled, apparently by Gen. Marshall. Unwilling to override the desires of commanders in the field, Marshall chose to have the T26s produced for Devers, but declined to force the tanks on anyone else. On 16 December, Maj. Gen. Russel L. Maxwell, the Army's G-4 and responsible for all logistical matters, wrote to Somervell: "It is directed that immediate steps be taken to effect the early production of 250 additional T26 tanks to fill

the operational requirements of the Commanding General, ETO . . ."[54] Marshall cabled Devers about his decision five days later, but estimated at least a nine month delay before production could start.[55] Thus, despite McNair's vehement opposition and a negative response from the only theater that had experience in combat, Barnes had won a major victory for his pet project only three months after he had first proposed production.

However, Barnes's victory was soon challenged. Late in December, Devers became Deputy Commander of the NATO and, ultimately, commander of the invasion of southern France. At the same time, Eisenhower left the Mediterranean for Great Britain to become commander of Supreme Headquarters Allied Expeditionary Force (SHAEF), which also made him commander of ETO. Since Eisenhower had opposed the T26 in November, ASF wondered if the decision to produce it for ETO should be reconsidered. ASF also objected to the inevitable delays in production of the T26: "It is . . . apparent that this tank will not be available for the early part of planned major operations in ETO." General Clay pointed out several factors that would delay the T26. It would be difficult to establish a facility for production of the tank's new transmission which was a "radical departure" from previous experience, in addition to "the usual difficulties attendant upon putting a pilot model into assembly line production . . ."[56]

Gen. Maxwell answered Clay that the delays had already been taken into consideration and brought to the attention of the theater commander. Further, the enclosures attached to Eisenhower's letter of 14 November, upon which he had based his objections to the T26, did not completely reject the tank. Maxwell quoted Gen. Harmon of the 2nd Armored Division:

> There may be opportunities in special situations for the employment of very heavy [sic] armed and armored tanks; therefore, a few battalions of this type should be procured, but to procure large masses of this type would be a mistake since they cannot be maneuvered or fought over the average type of terrain and in the average situation such as the Armored Division should be expected to be employed.

In a similar vein, Harmon had commented that "the weight of both the T25 and T26 makes them undesirable types for an armored division, but they might well be considered for use with special

GHQ tank battalions." Since the production of 250 tanks would only supply enough for about four battalions, Maxwell directed Clay to let the production order stand.[57]

Gen. Marshall swiftly settled the War Department's uncertainty concerning Eisenhower's views on the T26. In January 1944, Marshall cabled Eisenhower asking, "Has any change in this requirement arisen to make advisable delay or cancellation of project [T26 production]?"[58] Eisenhower's response reaffirmed the requirement and ended resistance to the production order. It is very possible that British influence affected Eisenhower's decision. A few days before Eisenhower cabled, British representatives of the International Supply Committee, acting according to instructions received from London, requested "consideration to our requirement" for 500 T26s.[59]

So the controversies of 1943 finally ended. Although overruled by Marshall on tank armament, Gen. McNair had made sure that his tank destroyers would also be well armed; Gen. Barnes had finally won his battle to get production orders for the T26. Even so, the red-penciled note of some unknown staff officer in ETO on Marshall's message about the nine month delay would prove to be prophetic: "We can forget this one."[60]

6

Combat in Europe 1944

American officers' confidence in their ability to defeat German tanks remained unshaken during the spring of 1944. Continued fighting in Italy did nothing to dispel this complacency. Germany hurled both Tigers and Ferdinands at the Anzio beachhead during a major attack in February 1944, but Allied Forces repulsed them. Those behemoths could not compensate for massive Allied firepower. Artillery was probably more important than tanks or tank destroyers in defeating the Germans, but once more there was no demonstration that the latter weapons were terribly deficient.[1]

After the breakout from the Anzio beachhead, American forces finally encountered the Panther, which had first gone into action at Kursk in 1943. Yet the tank does not seem to have particularly impressed United States troops. Gen. Devers, now in the Mediterranean, commented that an M5 light tank had destroyed a Panther with its 37-mm gun by getting "their rounds off before the lumbering Panther could swing its big gun into action."[2] Panthers earned more respect later as an extremely dangerous foe.

The Panther was a direct result of German 1941 experience with the Russian T-34. German soldiers had demanded something to cope with the sturdy Russian tank, and designers began work on the Panther in 1941. They copied the sloped armor of the T-34 and added their new, long 75-mm gun (Kwk. 42). Fortunately, previous German work on the Tiger provided a sufficiently powerful engine and the technology necessary to a strong suspension system. The Panther's layout—engine in the rear and a mechanical transmission in the front—was in accord with previous German experience. The vehicle was in production by November 1942. The Germans hurried 250 Panthers to the front in 1943, delaying their Kursk offensive until the tanks arrived. Not surprisingly, teething troubles forced all

the survivors back to their factory in Germany for major modifications.[3] The German army was not satisfied that the Panthers' difficulties had been corrected until March 1944, and even then the tank remained notoriously unreliable.[4] Still, it could destroy Sherman tanks at 2,000 yards, and its frontal armor was impervious to the American 75-mm gun. This was due to the only real innovation on the Panther—thick, steeply sloped (55 degrees) armor—a feature to which the Allies had paid little attention.

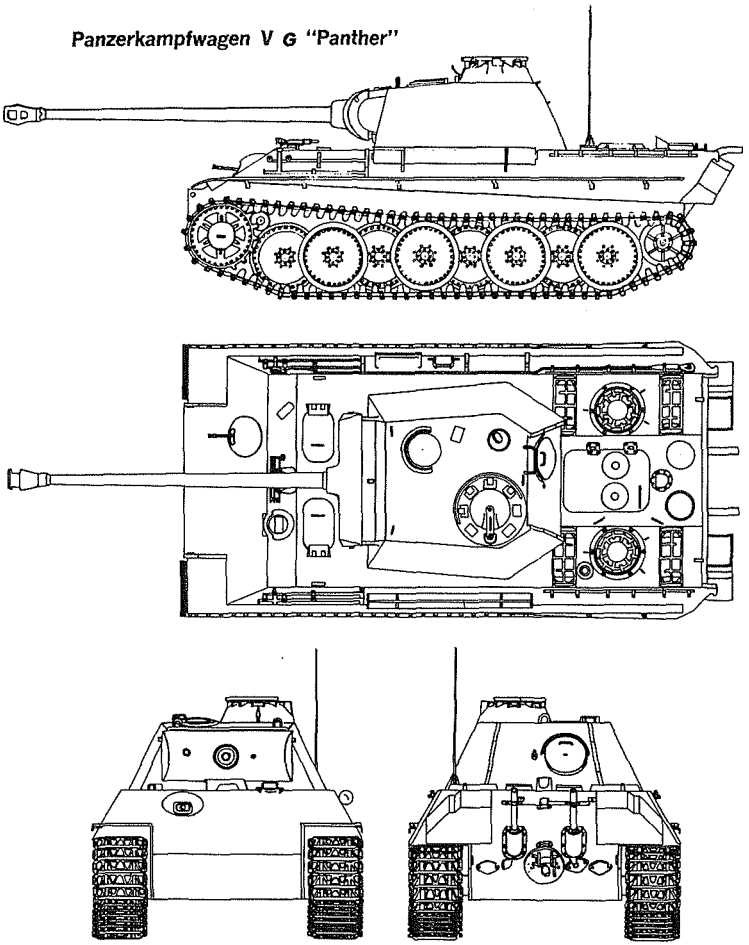


Fig. 16. The Panther. Source: Spielburger and Feist, *Panther,* p. 55.

The British and Americans conducted firing tests in England on 23 May 1944 to compare the 17-pounder, 90-mm, 76-mm, and 75-mm guns. But slabs of armor angled at 30 degrees gave no prediction of the success of those guns against German tanks. It reassured the British that their gun could penetrate 120-mm of armor, and showed the Americans that the 76-mm gun could pierce 100-mm, which was the thickness of the Tiger's frontal armor. The 90-mm's surprisingly bad performance was blamed on fuses detonated prematurely. To no one's surprise, the 75-mm gun could penetrate neither of the thick slabs, but this fact seemed to cause no consternation.[5]

Ordnance Department data supplied in 1944 did not stir the men in Europe to do more testing. That data showed that the Panther's slanted hull was immune to frontal attack by anything but the 90-mm gun. But their data assured its reader that the Panther's 3.9-inch turret front could be penetrated by the 76-mm gun at ranges over 1,000 yards. The data failed to take into account the fact that the Panther's gunshield, which covered most of the turret front, was sharply curved (see Figure 16). In fact, the effective thickness of the shield was 3.9 inches only at the exact apex of the curve. Hitting this precise location with an armor piercing shell would prove nearly impossible in combat. Further, the myth held that the 76-mm gun could penetrate the front of the Tiger at ranges over 1,000 yards.[6]

ETO officers had already indicated their lack of concern over destruction of German tanks. Production of the Sherman with the 76-mm gun had begun in January 1944, and at least fifteen would be available for D-Day with 600 more due in June and July. On 20 April a board of officers at ETO met to discuss how the new tanks should be issued. They agreed that there was little time to train troops with them. Gen. Gaffey of Patton's staff complained that the tank had "bugs" which should be ironed out before the tank was issued. The members of the board had noted that the gun's high-explosive performance was inferior to the 75-mm, and its severe muzzle blast tended to make it a one-shot weapon. In May they discovered that muzzle smoke (not dust) obscured the tank commander's view of a target 1,000 yards away for three to six seconds, despite a stiff breeze. The Board declined to issue the new tank since training problems and muzzle blast were ". . . an excessive price to pay for an additional inch of armor penetration."[7]

By May the theater's concern about German armor had not

increased. The War Department's G-4 asked ETO to specify their requirements for 1945 tank weapons in order to settle quarrels in the United States. Gen. Eisenhower responded that the theater wanted one 90-mm gun for every three 105-mm howitzers.[8] Brig. Gen. Joseph A. Holly, Eisenhower's staff agent for tank problems and formerly Devers's "engineman" for development at Fort Knox, was convinced that most tank targets would be personnel, machine guns, and other objects requiring a high-explosive weapon. The 105-mm howitzer could fill this need, and a version of the howitzer had already been mounted in a Sherman tank. Gen. Holly maintained his position, despite his accurate prediction that the 76-mm gun would not penetrate the Tiger frontally. He made no judgment about the Panther, although he believed that it was one of the most important German tanks.[9] His assessment of tank armament would not change before D-Day. Equipment for tank destroyer units also reflected a lack of concern for German tanks.

Even though Gen. Holly asked for 90-mm guns, the need for those guns to deal with heavy German tanks was not a matter of immediate concern. Gen. Eisenhower, responding to a War Department query in May 1944, mentioned training requirements and concluded that "No T-71s [M36s] are desired at this time for converting Bns now under our control."[10] The training of invasion forces was of course very important by May 1944, and Eisenhower's rejection of tank destroyers with the 90-mm gun indicated that he felt no pressing need for the gun. All theater commanders agreed that they would prefer to receive units already equipped and thoroughly trained with new weapons, rather than attempt to issue new weapons to units already in the field.[11]

Their resistance to re-equipping units had been made evident when the War Department had offered forty M18s to ETO in February. They were refused because the theater did not want to re-equip units at that time. The NATO accepted forty for shipment in March. Most of the M18s available in the United States went to fourteen tank destroyer battalions training there.[12] They slowly reached the front as the new battalions were deployed, and only 306 (compared with 790 of the slower M10s) were in the hands of troops by 20 December 1944.[13]

Of course the need for the M18 was even less compelling than the need for the M36. The M18 had no more firepower than the M10 and was more lightly armored. Planners in Great Britain who had

not seen the M18 would not appreciate its nimbleness until they saw it in action. In any case, the man charged with the American part of the invasion, Gen. Bradley, preferred towed anti-tank guns. Planning reflected this fact.

By 23 March 1944 there were nineteen tank destroyer battalions in Great Britain, sixteen self-propelled and three towed. Final plans intended to redress the balance of towed and self-propelled weapons, calling for equal numbers of each type. On D-Day there were nineteen self-propelled battalions and eleven towed units equipped and ready for combat.[14]

The number of tank destroyer battalions planned for the overall campaign following the invasion also indicated declining concern for the German tank forces that had seemed so awesome in 1941. Originally the plan called for seventy-two tank destroyer battalions. By November 1943, Gen. Bradley approved reduction of the number to fifty-two.[15]

Though their numbers were reduced, the men in tank destroyer units must have been encouraged by the fact that they would be employed according to their doctrine. Plans called for a tank destroyer group to be attached to each corps to control however many tank destroyer battalions were needed to oppose the armor threat.[16] This idea was exactly the doctrine recommended by FM 18-5. But the Normandy countryside was poorly suited for the employment of large numbers of tanks; hedgerows provided constant obstacles. Further, most of the Panzer divisions became committed against the British further to the east. As a result, small German tank attacks in the American sector were aimed at limited objectives. This created pressure to disperse tank destroyers among frontline units, rather than leave them concentrated in reserve positions as doctrine dictated. Because of "the piecemeal employment of German armor," tank destroyer battalions were rarely attached to groups. The various group headquarters quickly became advisory groups ". . . interested in seeing that the tank destroyer battalions were adequately supplied and gainfully employed."[17] The concept of massing tank destroyers succumbed to the tactical situation. It would not be revived even when needed.

The situation described above illustrates the most fundamental problem of tank destroyer doctrine and organization. Tank destroyers were defensive units in an army that was almost continuously on the offensive from 1942 to 1945. They never faced the

massed German armor of 1940 because those formations had been severely depleted in Russia, and their remnants hid from Allied airpower. Commanders therefore became used to dispersing tank destroyer units; they had little reason to do otherwise. Ironically, the effectiveness of tank destroyers was finally measured by their ability to perform offensive operations for which they had not been designed. The doctrine developed in 1941 and 1942 and was usually inappropriate for the situation in 1944, and commanders in the habit of dispersing tank destroyers refused to mass them even when the situation begged for it.

Such a situation occurred shortly after the breakout at St. Lo. During the first days of August 1944, American units were pouring through the gap that had been opened at St. Lo. Hoping to stem the tide and cut off a large American force, Hitler ordered an attack against the chokepoint at Avranches. The Germans assembled two corps which included four Panzer divisions for the attack.[18] Fortunately, the Allies were warned of the attack by Britain's Ultra organization, which decoded German messages throughout the war.[19] Despite the warning, tank destroyers were not massed. Instead, the 30th Infantry Division and its single attached tank destroyer unit, the 823rd TD Battalion with thirty-six towed guns, met the brunt of the German attack.

On 5 August 1944, the 30th Infantry was attached to VII Corps and ordered to relieve the 1st Infantry Division in the vicinity of Mortain.[20] Typically, the division ordered the 823rd to attach each of its companies to a regiment of the division.[21] Assured that the sector was quiet, the 823rd occupied the same positions as the previous tank destroyer unit. Unfortunately, some of the positions were exposed and lacked protection from friendly infantry.[22] Thus, when the German attack came on 7 August, the 823rd was dispersed, unprepared, and in some cases unsupported.

Receiving only twenty minutes warning from the 30th Infantry Division, the 823rd came under attack during the first hours of 7 August. By daylight the German attack was well underway. The third platoons of both A and B Companies were in exposed positions. A Company's third platoon, unprotected by American infantry, quickly succumbed when German troops swept around their positions and chased crews away from their guns with small arms fire.[23] The platoon from B Company fared little better. Although that platoon was able to destroy two German tanks, "The heavy towed

tank destroyer guns were sitting ducks when they revealed their locations by firing."[24] Other units of the 823rd were more fortunate, but the situation in the 30th Division's sector was very serious. As the unit's historian noted, "with a heavy onion breath that day the Germans could have achieved their objectives."[25] But at the end of the day, American forces aided by tactical airpower had stopped the German attack.

The 823rd destroyed fifteen German tanks but also sustained heavy losses. By the end of 7 August, the battalion had lost eleven guns with their prime movers (halftracks); three soldiers were dead, and 101 were missing.[26] Most of the losses came from the two platoons that had been overrun in their exposed positions.

One incident on 7 August clearly illustrates the difficulties created by commanders who failed to employ the tank destroyers as a cohesive battalion deployed defensively according to doctrine. At about 0630 hours, the division ordered the 823rd to cover the southern flank with tank destroyers "at once." After the battalion commander reminded the division that he had not a single tank destroyer under his control, the division gave him a platoon from C Company, which was not in contact with the enemy. However, the 119th Infantry regiment refused to release the platoon until noon.[27] Fortunately, the delay did not prove to be critical since the Germans did not attack in the south.

The sad fate of the 823rd was largely due to the immobility of its guns. Unable to fire and run, the men of the 823rd stood, fought, and were overrun. Although the doctrine of FM18–5 published in 1942 may have been inappropriate in 1944, the changes in that doctrine dictated by generals with "combat experience" would subsequently prove to be worse.

Even before the invasion the towed tank destroyer battalions that Bradley had demanded in 1943 began to fall short of expectations. Planners had hoped to attach a towed battalion to each division and retain self-propelled battalions as corps or army reserves. This solution partially agreed with doctrine in FM 18–5 since it compensated for the lesser mobility of towed guns. Amphibious exercises prior to the invasion revised planning by revealing the vulnerability of towed weapons when unloading and going into action. Therefore only one towed battalion was present in the initial invasion while several self-propelled units participated.[28]

The limitations of towed guns became more evident soon after

D-Day. Divisions that had not been in the initial landings began requesting self-propelled tank destroyers to replace towed units for several reasons:

> (1) the organic need for an armored self-propelled assault gun in the infantry division; (2) the inability of the towed gun to shoot direct fire over the hedgerows; (3) the thin armor of the towed gun which made it impossible to push it far enough forward to take advantage of the small field of fire defined by the hedgerows; and (4) the immobility of the towed gun once emplaced.[29]

The weapon that had seemed so desirable in Africa became a white elephant in different terrain.

As Americans slogged through the bocage they found that the small fields surrounded by high, thick hedges compensated for the technological weakness of American tanks. The terrain resulted in engagements at short range for which the efficient power traverse of the Sherman was often more telling than the ability of German tanks to destroy Shermans at long range. The thick vegetation sometimes obstructed the long barrels of the German cannon. An American tanker observed later that GIs were often able to fire three or four rounds as the Germans slowly traversed their turrets.[30] But a better traversing system could not fully compensate for the troops' difficulties with heavy German tanks, and senior commanders finally became aware of this.

Aggravated by the tough hide of the Panther tanks during the first weeks of the Normandy campaign, the First Army set about finding exactly what weapons could destroy that tank. A board of officers moved a Panther to a suitable location and fired at it with virtually every weapon available, including rifle grenades, 40-mm anti-aircraft guns, and 105-mm howitzers. The results were disheartening. Three-inch guns had a chance against the turret mantle at very short range, 200 yards. Only the 90-mm gun and the 105-mm howitzer proved capable of penetrating the Panther's glacis plate. But the low velocity of the 105-mm's shaped-charge ammunition (1,020 fps) made it nearly impossible to get hits beyond 500 yards.[31] In addition, the few M4 tanks equipped with the 105-mm lacked power traverse, which made their crews very hesitant to engage German tanks.[32] The 90-mm gun was credited with penetrating the Panther's front from 600 yards. But even this was disputed in a later

Fig. 17. A crew struggles to emplace its 3-inch gun in Germany, 1945. Source: U.S. Army Photo.

test. The 703rd Tank Destroyer Battalion with M36 tank destroyers firing in early December 1944 was only able to make penetration about half of the time at ranges of 150 to 300 yards. In addition, the commander of the 703rd concluded that the 90-mm was ineffective against the King Tiger's frontal armor.[33]

In any case, the First Army tests caused considerable excitement among senior American commanders. Gen. Eisenhower remarked angrily:

> Why is it that I am always the last to hear about this stuff: Ordnance told me this 76 would take care of anything the German had. Now I find you can't knock out a damn thing with it.[34]

Eisenhower quickly took action to rectify the situation. He dispatched Gen. Holly with a letter for Gen. Marshall demanding tanks and tank destroyers with 90-mm guns. General Marshall expedited shipment of M36s and assured Eisenhower that the high priority of the T26 should assure its arrival very soon.[35]

Gen. Bradley, Commander of the Twelfth Army Group, reacted by ordering that 90-mm anti-aircraft guns be deployed in an anti-tank role. In addition, he requested British M4s with the 17-pounder

gun.[36] His request for Fireflies was unfilled because ETO would have had to provide M4s for the conversion. ETO was unable to do this because of a serious shortage of Shermans. Units were forced to operate at 75 percent to 87 percent of their strength because the War Department had earlier based replacement rates on a lower attrition factor and higher shipping speeds than what eventually transpired.[37]

Even the Fireflies would not have solved the problem. The ability of the 17-pounder to destroy German tanks became a post-war legend that was not supported by the experiences of British soldiers who manned Fireflies. The 44th Royal Tank Regiment recorded that the 17-pounder "only nicked" Panthers.[38] Tankers of the 23rd Hussars provided more conclusive evidence.

> 'C' Squadron also conducted a trial shoot of our weapons against the front of a Panther, with rather depressing results. The open piece of ground on which we were sitting contained about eight knocked-out Panthers, all bearing signs of considerable disorder in their ranks. We learned later that our friends the Twenty-fourth Lancers had been responsible both for their disorder and their battered condition. They had, however, been knocked out from the flank, and we were anxious to see what effect a Sherman would have on the front of a Panther, should we find ourselves in the unfortunate position of having to tackle one or more frontally. It was found that a 75-mm gun made no impression on the front at all, unless it was lucky enough to hit the turret ring, a very small target indeed. The 17-pounder was more encouraging (as related earlier we were equipped with one 17-pounder tank for every three 75-mm) for it penetrated the front of the Panther's turret at 300 yards, though it did not always go through the sloped front plate of the hull. On the whole, we decided that head-on Panthers should be treated with circumspection. In point of fact we found ourselves in just that position a few days later, and the results were just as unhappy as our trial shoot indicated.[39]

The unscientific but effective test conducted by the 23rd Hussars clearly disagrees with post-war analyses. G. MacLeod Ross, for example, contends that the 17-pounder could penetrate a Panther's frontal armor at 2,000 yards.[40]

The comparison tests fired in England prior to D-Day had shown the 17-pounder to be slightly superior to the 90-mm gun at close ranges. The 17-pounder had no clear advantage over the 90-mm until the fall of 1944 when the English introduced sabot ammunition with extremely high velocity.[41] The sabot ammunition proved to be wildly inaccurate in another comparison test between the 76-mm gun and the 17-pounder conducted by a Twelfth Army Group board in August. A British observer claimed it was a bad lot of ammunition, but Americans had had similar experience with British sabot ammunition for the 57-mm gun. A plausible explanation of the confusion regarding penetration capabilities cropped up in the test just mentioned. The members of the board found that the quality of the armor plate varied considerably among the three Panthers used for the test. Apparently the results achieved on any test depended upon the particular tank used as a target.[42] But the firing tests in August were discouraging.

One of the main objectives of the August tests was to evaluate the new hyper velocity armor piercing (HVAP) round for the 76-mm gun. The Ordnance Department had increased the penetration of 3-inch and 76-mm ammunition by using a new projectile, which consisted of a small, hard tungsten carbide core encased in an aluminum body. The result was lighter than the normal armor piercing projectile and it had a higher velocity (3,400 fps vs. 2,600 fps). Even this new ammunition could not penetrate the front slope of the Panther. But HVAP rounds offered a better chance to penetrate other areas of the tank's frontal armor, and the troops wanted all the new ammunition that they could get. Supply, however, could not keep pace with demand due to the critically short supply of tungsten carbide. The resulting ETO rate of supply was only two rounds per month for each gun in the theater.[43]

The Ordnance Department, obviously shocked by the tests in July, also took steps to increase the penetration capability of the 90-mm gun. Their simplest solution was to use more and better powder. This increased the muzzle velocity from 2,650 fps to 2,800 fps, but it was still not enough to penetrate the Panther. The next step was to modify the heat treatment of the projectile while at the same time providing a cap to reduce wind resistance. Combining the new projectile with the higher velocity finally produced the T33 round, capable of penetrating the Panther's glacis plate at a range of 1,100 yards. Ordnance engineers also developed a HVAP round for the 90-

mm gun. This was the only round that could penetrate the front of a Royal Tiger, albeit at the short range of 100 yards.[44] Both types of ammunition reveal the difficulty in relating scientific theory to battlefield results.

The proven ability of the T33 to penetrate the Panther's frontal armor vividly illustrates the error of using figures from the proving ground to predict the performance of weapons in actual combat. The following table shows some of those experimental figures:[45]

TABLE 3

Penetration Performance Against Armor Angled at 30°

Gun Type and Ammunition	Range 500 yards	Range 1,000 yards
76-mm (M79 AP—solid shot with ballistic cap)	109	92
76-mm (M93 HVAP)	157	135
17-pounder (Mark VII—solid shot with ballistic cap)	140	130
17-pounder (SVDS—discarding sabot)	208	192
90-mm (M82 AP—shot with explosive filler)	120	112
90-mm (T30E16 HVAP)	221	199
90-mm (T33 AP—solid shot with ballistic cap)	119	117

From the above information, the T33 is clearly inferior to all rounds except the 76-mm M79—despite its proven performance against tanks, rather than the slabs of armor plate. The technological confusion is further illustrated by the fact that the best round, 90-mm HVAP, could not penetrate the front of the Panther's steeply sloped hull. Clearly, engineering figures based on test approximations of enemy armor may prove very misleading. In any case, American soldiers had to do without both the 90-mm T33 and HVAP ammunition; neither type reached them until March 1945.

By July 1944 there was no way for American technology to react to the need for better guns before the war ended. Recognition of the problem in 1944 only made the failure to identify it in 1943 more distressing. American troops would have to fight with weapons in production or about to enter production, and those would not arrive for months.

Although Gen. Marshall had ordered that M36s be shipped during July, the new tank destroyers did not reach the troops until September and October 1944.[46] The delay was probably due to two factors: the time required for the sea voyage and the tactical situation

at the end of the voyage. Shortly after the First Army tests, American soldiers broke out of the confines of Normandy and began an exploitation that soon made tactical problems subordinate to those of logistics. Any combat commander in France during August and September 1944 would doubtlessly have preferred to see 30 tons of gasoline arrive in his area rather than 30 tons of tank destroyer.

The fast exploitation through France showed the M4 at its best. The dependable Shermans rushed toward Germany, destroying retreating German columns whenever they found them. Worries about German tanks faded as Allied armies raced to end the war by Christmas. Those worries also diminished because the M4 tanks held their own in mobile battles during the fall of 1944.

The largest of these battles were fought in Lorraine. France's 2nd Armored Division encountered the 112th Panther Brigade on 14 September and crushed it. The Germans left thirty-four of their forty-eight Panthers and twenty-six of forty-eight Mark IVs rusting at Dompaire. On 17 September the 113th Panther Brigade struck Combat Command A (roughly equivalent to a regiment) of the 4th Armored Division. Attacking in thick fog with forty-two Panthers and a similar force of Mark IVs, the German thrust first hit the 37th Tank Battalion which had only one medium tank company available. Warned by his own patrols, the Battalion Commander, Lt. Col. Creighton Abrams (later Chief of Staff of the Army), caught the Germans in a foggy ambush. When the fog lifted, Abrams found a score of factory-new Panthers burning.[47] The M4 could kill Panthers when it could use its maneuverability to get shots at the flanks of the German tanks. Previous tests had shown that even the 75-mm could penetrate the sides of the Panther at a range of 1,500 yards. It was even possible to destroy Panthers in frontal engagements by the risky method of ricocheting shot off the rounded turret front of the Panther and through the thin armor on top of its hull.[48]

The battle at Arracourt was also a high point for tank destroyers. Gen. Bruce's "ideal" tank destroyer, the M18, proved its worth that day. The 704th Tank Destroyer Battalion was attached with its Hellcats to the 4th Armored Division immediately after its arrival in France in July 1944. The 704th then accompanied the division through August and September. Like the 823rd at Mortain, the 704th was soon dispersed among the combat commands.[49] When the Germans hit the 37th Tank Battalion on 17 September, C Company was also part of CCA. Two platoons manned an outpost

line while the third platoon was in reserve at CCA headquarters.[50] After learning of the attack on Abrams's battalion, the commander of CCA ordered the third platoon to establish an outpost line between his headquarters and the Germans fighting Abrams. Unaware of the actual situation, the platoon leader, Lt. Edwin Leiper, raced off into the fog with his M18s. Approaching the hill, Leiper suddenly spotted the muzzle of a German tank gun some "30 feet away" as the excited lieutenant later remembered. He gave the dispersal signal and his well-trained platoon quickly deployed and opened fire. In minutes five German tanks had been destroyed; only one M18 had been damaged. Remaining on the hill until afternoon, the platoon destroyed ten more tanks, although they lost two more M18s.[51] The platoon's losses, sustained while destroying fifteen German tanks, were in sharp contrast to those of the 823rd Tank Destroyer Battalion on 7 August.

The maneuverability of the M18 played a major role in this action and in the remainder of the battle:

> It was also generally agreed that the tank destroyer missions at Arracourt could not have been as well performed by heavy tanks . . . in as much as the tank destroyers were able to utilize speed and maneuverability over rough and muddy terrain over which [heavy] tanks would have been unable to move.[52]

Successful actions such as the one at Arracourt did nothing to build the reputation of German tanks, yet they are not the main reason that the issue waited until 1945 for public exposure.

Rather, the newer and superior German tanks were simply scarce until late in the war. Table 4 shows that the Mark IV remained the most important German tank until well into 1944. And, although this table does not break down the numbers of Mark VIs into the older Tiger I and new Tiger II, the table shows clearly that there were few Tigers available to meet the Normandy invasion.[53]

TABLE 4

German Tank Strength in Italy and in Western Europe

	February 1944		June 1944
	Italy	West	West
Mark III	106	99	39
Mark IV	171	587	748
Mark V	0	290	663
Mark VI	8	63	102

Fig. 18. The M18 in Germany, 1945. Source: U.S. Army Photo.

Table 5, although it does not divide German tank strength between East and West, reaffirms that the Mark IV formed the backbone of German tank strength until late in the war. The table is also interesting because it shows that the Tiger II was very scarce indeed.[54] The decline in numbers of the Tiger I reflects the fact that it went out of production in August 1944.

TABLE 5

Total German Army (East and West)
Tank Strength Ready for Action

	September 1943	January 1944	June 1944	December 1944
Mark IV	1203	1492	2138	1630
Mark V	601	1084	1898	1966
Mark VIB (Tiger I)	284	395	615	243
Mark VIB (Tiger II)	0	0	31	166

These tables show that heavier tanks formed only about half of total German tank strength. The Sherman and available tank destroyers were fully capable of dealing with the Mark IV, the most numerous tank. This fact goes far to explain the overall success of the United States armored divisions in defeating German armor.

The actual number of superior German tanks in action on the front never lived up to the number reported by American soldiers. In the heat of battle, there was a tendency to call every German tank a Tiger and every anti-tank gun an 88-mm (although 75-mm anti-tank guns far outnumbered the 88s). At combat ranges of 500 to 1,500 yards, tanks, particularly German ones, look much alike. The numbers of the King Tiger (Mark VIB) are particularly interesting since reporters often used these tanks as a basis of comparison with the Sherman. Their comments implied that American tankers were mainly encountering Royal Tigers, but these tables suggest that this obviously was impossible.

An important reason that American soldiers failed to recognize German tanks was that they saw so few of them. Encounters with German tanks were not a daily occurrence. Prying German infantry and guns from well-prepared positions was the more typical problem. Even tank destroyers were engaged in this type of mission more often than fighting enemy armor. From August 1944 to February 1945 the First Army's 3-inch guns, found only in tank destroyer units, fired 337,367 rounds of high-explosive shell versus only 29,210 rounds of armor piercing ammunition.[55] But fighting German tanks became more difficult as the Allies approached Germany.

Europe's wet winter and more difficult terrain near the German border began to hamper operations. The first real setback for American tanks came in November at Puffendorf, Germany. Mud robbed the 2nd Armored Division's Shermans of their ability to maneuver for shots at the vulnerable flanks of German tanks. Panthers and Royal Tigers stopped two battalions of the 2nd Armored and dealt them heavy losses. Only the fortuitous arrival of some M36s salvaged the situation. The paucity of American experience in tank vs. tank combat is best illustrated by this action. This "biggest tank battle in 2nd Armored Division experience" involved only twenty-five German tanks.[56]

Lack of experience against German tanks did not stop Americans from judging their tank destroyers. Towed guns continued to lose popularity. The mobile, easily handled 900-pound 37-mm gun which had convinced McNair in 1940 that towed guns were maneuverable enough to fight tanks, had grown into the unmanageable 5,000-pound 3-inch gun. Tank destroyers, like tanks, had to find the flanks of Panthers and Tigers in order to destroy them; neither the 3-inch nor the 76-mm gun could penetrate the front of those tanks at

practical ranges. Self-propelled guns were able to do this far better than towed ones. Besides their superior ability to destroy tanks, self-propelled tank destroyers proved to be generally more useful than towed weapons. One tank destroyer officer commented that

> . . . the appearance and knowledge that self-propelled tank destroyers were at hand was a major reason that the infantry attained success and victory. . . . The towed guns can be just as brave and thoroughly trained but they never give much "oomph" to the fighting doughboy when the "chips are really down."[57]

Senior commanders agreed and requested more self-propelled units in September. After coordinating with the War Department, ETO decided to begin converting towed units in the theater to self-propelled equipment. In November, the War Department found that ETO wanted forty self-propelled battalions and twelve towed. All towed units were to receive 90-mm guns.[58]

The other arms generally held the tank destroyers in high regard, but there were exceptions. Training and morale varied among tank destroyer battalions. Further, the status of tank destroyers as an attached unit often meant that companies and platoons suddenly found themselves joining an infantry or armored unit just prior to combat. Unfamiliarity bred mutual mistrust, sometimes with unfortunate consequences. One commander of an infantry regiment commented on his attached tank destroyers:

> Company C [number omitted] Tank Destroyer Battalion was probably the most dependable attached unit which I commanded. It uniformly *failed* in all its assigned tasks! It possessed no fighting spirit whatsoever, and was happiest when well to the rear, or tagging along behind the tanks. It was useful on road-blocks and defensive situations, where they [sic] served to deter the enemy if he should see them.[59]

Fortunately, those comments were not typical.

The effort to convert towed battalions to self-propelled guns was still under way in December 1944. In general, units with M18s were new units equipped in the United States. The M36s replaced either towed guns or M10s. Excess M10s were given to towed units as the vehicles became available. Some units were in the midst of conversion when the greatest challenge to tank destroyers began.

After massing nearly 1,500 tanks and self-propelled guns, Hitler struck through the Ardennes in December 1944. For the first time the American troops faced the task of stopping massed German armor. There was no opportunity to mass tank destroyers as advocated by FM 18–5. Unwarned by "Ultra", the US Army was surprised by the Germans.[60] The attack found American units spread thinly among the forest and ridges of the Ardennes with tank destroyers dispersed among them. Bad weather, which hampered Allied airpower, favored the Germans. The broken terrain did not compensate for the limited range of American tank guns as well as the hedgerows in Normandy had done.

Tank destroyers played a crucial role throughout the battle, since the attacking German formations involved included many armored vehicles. But even after the Allies realized the scale of the attack, there was no attempt to group tank destroyers. The Battle of the Bulge was a confused brawl that found American command and control fragmented. Combat commanders, from army commanders to squad leaders, fought their own local battles with whatever assets they found at hand. But the US Army history of the battle points out, "The mobile, tactically agile, self-propelled, armored field artillery and tank destroyers are clearly traceable in the Ardennes fighting as over and over again influencing the course of battle."[61]

Combat in the Ardennes completely discredited the towed guns of tank destroyer units. The towed guns' lack of mobility made them less effective than self-propelled guns and resulted in greater losses. Towed guns could not maneuver to obtain the flank shots necessary to destroy heavy German tanks. They could not advance to support a counter-attack and were almost inevitably lost when a retreat was necessary. For example, of 119 tank destroyers lost by the 1st Army in December, eighty-six were towed.[62]

The veteran of Mortain, the 823rd Tank Destroyer Battalion, contributed to those losses. Still attached to the 30th Infantry Division of the 1st Army, the 823rd was one of those units in the middle of conversion to self-propelled guns when the Germans attacked. The battalion had begun to receive M10s in early December and by mid-month had four per company. Hastily committed to battle on 17 December, the battalion's companies generally tried to use towed guns in forward positions and retain the M10s as a mobile reserve. In a typical action, the 823rd Tank Destroyer Battalion recorded that "Upon the withdrawal of friendly Infantry, tank

destroyer guns were one by one flanked by enemy tanks and personnel driven from the guns by small arms and machine gun fire . . ."[63] Nine guns were lost in the incident.

On 29 December, Gen. Holly wrote to the War Department: "100 percent self-propelled tank destroyers now desired. Towed people are quiet these days."[64] As a result of losses in the Ardennes, ETO asked to convert all towed battalions to self-propelled equipment.[65] The War Department approved the theater's request on 11 January 1945.[66] Thus towed guns, demanded as a result of early combat experience, were abandoned as a result of combat experience.

Combat commanders now viewed the self-propelled tank destroyers with esteem. The Third Army was so enthusiastic about the M18's mobility that they referred to the vehicle as "the finest piece of tracked equipment in the US Army."[67] However, views concerning tank destroyers were not unanimous. While the Third Army preferred mobility, the First Army desired heavier armor instead of speed.[68]

The available M36s proved to be a blessing during the Battle of the Bulge. Often the M36 was the only weapon capable of dealing effectively with the heavy German tanks. For example, one narrative of the fighting near the Elsenborn Ridge related the following incident:

> Powers [Lt. Powers of the 740th Tank Battalion] slowly pushed on, having no idea what lay ahead. A second big tank loomed up. Before the German could fire, Powers sent a round into the Tiger's front slope plate. The shell bounced off harmlessly.
>
> Powers' gun jammed. Since the radios were useless, he hand-signaled the tank destroyer to move in. The Tiger, jarred by Powers' first shot, fired two wild rounds. Then the American tank destroyer's big 90-mm roared. The Tiger flamed.[69]

But there were not enough M36s. By 20 December there were only 236 of them among the troops.[70]

American tanks had to bear a major share of the defense. Most Shermans still had the 75-mm gun. Losses soared as the tankers saw their shells bounce off thick German armor; meanwhile their Shermans went up in flames. Table 6 records these losses.[72]

TABLE 6

Monthly Losses of ETO, 1944–45

	20 October-20 November	20 November-20 December	20 December-20 January
M4 (75-mm and 76-mm)	257	495	585
M4 (105-mm)	11	28	29
M7 (105-mm SP howitzer)	3	105	0
M10	45	62	69
M18	7	44	27
M36	5	21	26

The cry for weapons capable of destroying Panthers and Tigers went out "prayerfully or profanely—wherever the enemy Panzer Divisions appeared out of the Ardennes hills and forests."[71] The troops were mad, and they told the correspondents. The lack of American firepower quickly spread over the pages of newspapers in the United States.

7

Development and AGF-Ordnance Disputes 1944

As American soldiers discovered the quality of their tanks in battle, quarrels over development became increasingly bitter in the United States. The T25, which had finally been approved for production during the last weeks of 1943, became the main issue of controversy.

Development of the forty T25s and ten T26s ordered in May 1943 never faltered during 1943 even though both AGF and ASF questioned the approval of Gen. Devers's request for mass production. Gen. Eisenhower's concurrence with Devers's request in January 1944 ended ASF's opposition. But technology could not be rushed. By 10 December 1943, drafting work was still only 95 percent complete on the T25 and an even slower 85 percent on the T26.[1] A pilot model of the T25 was completed in January 1945, and the T26 followed in February. (Production of the original order of forty T25s and ten T26s had been completed in May 1944).[2]

Development of the T25 and T26 was not opposed by AGF or the Armored Force in 1944 despite post-war claims of the Ordnance Department's spokesmen to the contrary. Only twelve days after Gen. Campbell, Chief of Ordnance, complained on 19 January that production of some other type of armored vehicle would have to be cut to provide Ford engines for the T26, ASF approved reduced production of the M7 105-mm motor howitzer carriage.[3] Thus the US Army's only self-propelled artillery weapon in mass production was cut by 341 units. ASF had again urged the Ordnance Department on 8 January "to expedite production" of the T26.[4] AGF cooperated with development in March by sending members of the Armored Board to Aberdeen to "shorten the time of tests."[5] (The Board did not usually participate in any tests until tanks arrived at Fort Knox.)

Despite unusual cooperation in an effort to complete tests on the T26 and thus get the tank into production, the first estimates for the start of production were not encouraging. The War Department had asked for tentative production schedules when urging production in January. The Ordnance Department's optimistic January response was quickly revised in February. The tentative schedules are listed below:[6]

TABLE 7

Tentative Production of T26

14 January 1944		19 February 1944	
July	15	October 1944	6
August	35	November	25
September	60	January 1945	40
October	60	February	50
November	60	March	50
December	20	April	29

After the war, Ordnance Department historians claimed that the T26s could have been available for D-Day had production been approved in September 1943 instead of three months later. Even if one could ignore the state of development of the T26 in 1943 and accept the optimistic view that an early order would have meant a corresponding advance in production, T26s could never have been available by D-Day. Subtracting three months from the Ordnance Department's own estimate in February 1944 results in the production of six tanks in July, hardly in time for the invasion. And even the February estimate proved optimistic.

The realization that there would be a long delay before T26s could reach Europe started a new development program. Heavy armor was one of the most important characteristics of the T26. ETO's request for the vehicle indicated that the soldiers in the field wanted a heavily armored tank quickly. So AGF proposed to satisfy the need by adapting the Sherman tank.[7] The AGF proposal was to increase the Sherman's armor by welding an extra one an one half inches of armor to the hull for a total of four inches. By the same means, the armor of the T23 turret could be increased to six inches. In March 1944 ETO responded favorably to the War Department's query, and the latter ordered production the same month.[8] By November 1944 the new tank, M4A3E2, dubbed "Jumbo" by the troops, was proving its ability to shrug off shells from German anti-

tank guns.[9] Gen. Patton was so impressed by the vehicles that he tried to insure that one led every column attacking toward Bastogne during the Battle of the Bulge.[10] AGF's account of this program lauds the Ordnance Department for doing a "magnificent job." But it pointedly notes that "the project was handled by the Ordnance Department Production and Engineering Divisions and the Technical Division [led by Barnes] was little concerned."[11] The speedy introduction of the Jumbo and its success in combat were further proof of the Sherman's adaptability.

The long delay indicated by the tentative production schedule for the T26 had not discouraged Campbell. He remained enthusiastic about the tank and called Barnes on 29 March to ask how the tests were going. Barnes replied that "From tests up to the present time nothing major has come up and it would be safe to order them in quantity. . . ."[12] Encouraged, Campbell finally made a direct proposal for large scale production. Writing to Brehon Somervell, Commander of ASF, on 31 March, Campbell recommended that orders be placed for at least 2,000 or preferably 4,000 tanks in order to get them into production on a quantity basis during 1945. Campbell assured Somervell that it was not important to decide the proportion of T25 or T26 tanks immediately, since "from a tooling standpoint both tanks were very similar." Campbell assured him that detailed changes in the design made necessary by service tests, could easily be made in the six or eight months before production started.[13] Gen. Somervell's representative, Lucius Clay, quickly passed the buck to AGF, commenting on 2 April that it did not seem advisable to begin retooling facilities unless a demand was established. But he left the decision to the officials of AGF if they were "prepared now to state that the model will be required in large numbers."[14]

AGF acted quickly to assure the success of Campbell's proposal. Apparently, AGF had queried the Armored Board about the desirability of mass production. Col. Frank R. Williams of the Board replied on 6 April recommending the following numbers of T25s with corresponding armament: 640 105-mm Howitzers; 4,560 75-mm guns; 2,400 76-mm guns. Williams did not want the 90-mm gun and its larger turret unless an actual need was established.[15]

After receiving the recommendations from the Armored Board, AGF quickly replied to ASF on 12 April: "This Headquarters concurs with the recommendations of the Chief of Ordnance . . ."[16] AGF then reinforced the request by transmitting the same require-

ment directly to the War Department's G-4, recommending the numbers and armament of tanks received from Williams. However, AGF qualified the recommendation by asking that the commander of ETO be questioned about desired armament and noted that AGF recommendations would be changed if necessary as a result of the theater's answers. In addition, AGF emphasized that its recommendations were not a request for production of the tanks in their present form, because of stowage and mechanical difficulties.

The Armored Board, which was also represented at the Aberdeen tests in March, had a far different impression of the results than the glowing assurances of Gen. Barnes. The Armored Command identified several major deficiencies. (Barnes knew of at least two of these, but apparently glossed over them when he assured Campbell that the tank was ready for quantity production.) Suspension components broke during operation. The coupling between the engine and transmission failed on several occasions. Ordnance engineers had forgotten that their torquematic transmission did not allow the engine to be used for braking, and this caused too much wear on the tank's brakes. Drive sprockets also wore excessively.[17]

In addition to all those defects, another major problem clearly illustrated the Ordnance engineers' failure to ask advice from tankers: stowage for ammunition was manifestly unsatisfactory. Besides the fact that only forty-two rounds could be carried, the system for stowage, carried forward from the T23, made the tank totally unsuitable for combat. Ammunition was stowed in metal satchels that each held two rounds. As the shells were used the satchels had to be removed to expose more ammunition. These satchels soon filled the turret but could not be discarded since they were needed when the tank was resupplied with ammunition.[18] Obvious defects such as this should have been identified at the mock-up stage, yet it was an inescapable fact that the problem persisted all the way into the prototypes. Reflecting a genuine concern for the users' point of view, the Armored Board objected vehemently to this feature. It is difficult to understand how this obviously defective ammunition stowage system remained unnoticed all the way into the prototypes, unless the tankers' point of view had been ignored during design. This flaw underlines the Ordnance Department's repeated failure to solicit the active and informed participation of the user early in the development process.

The AGF request illustrated still other disagreements between

AGF and Ordnance. Officers of AGF preferred the T25 over the T26. The men at the War College felt that the T26 was underpowered. Although it used the same engine as the T25, the T26 was about eight tons heavier. German engineers had been able to move toward bigger guns *and* heavier armor in the Panther while retaining satisfactory mobility because they had the Maybach V-12 with 690 horsepower available for the 45-ton tank. American designers were forced to rely on the Ford V-8 of only 450 horsepower since that engine was the best available during World War II. The Ford engine was adequate for the 35-ton Sherman and T25, but the extra weight on the T26 badly affected its mobility. During the Korean War, mountainous terrain clearly revealed the T26's lack of power, and old Shermans had to fill the gap as the primary American tank during that conflict's early stages.[19]

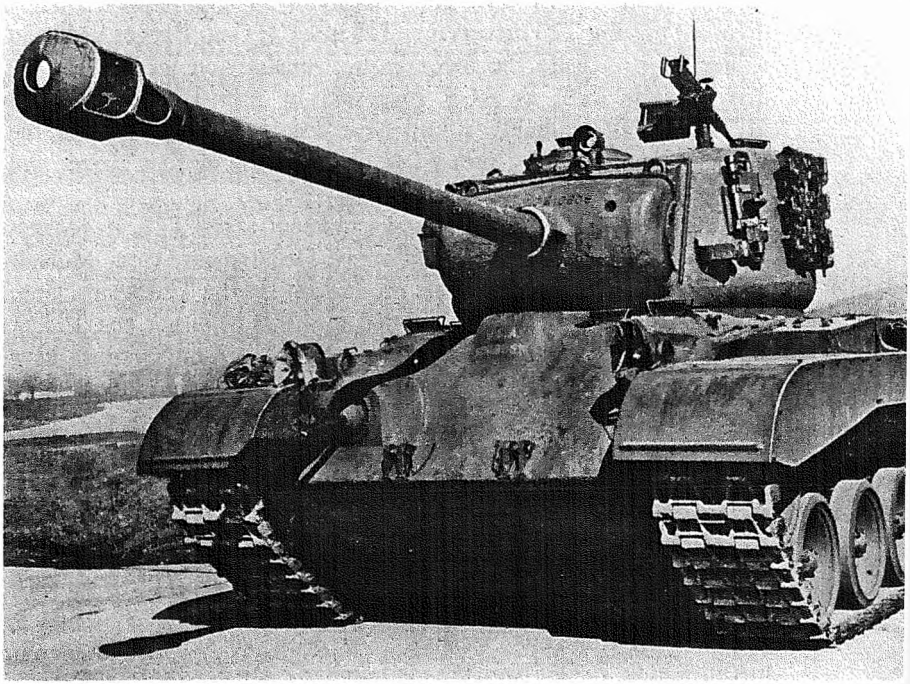


Fig. 19. The T26E3, standardized as the M26 "Pershing." Source: US Army Photo.

AGF's desire for 75-mm and 76-mm guns was largely due to its continued opposition to large guns in tanks. The Requirements

Section was also worried that ammunition for the 90-mm gun would be too large for the crew to handle efficiently.[20] Indeed, the size of 90-mm rounds did prove a problem. Interviews during the immediate post-war period revealed that tank crewmen generally believed that the 90-mm round was "too large."[21] The tankers apparently liked the 90-mm gun's ability to penetrate armor, but they did not necessarily like the gun itself. Tank crews and AGF wanted to improve the 76-mm gun so that its ability to penetrate armor would equal that of the 90-mm gun, but they opposed going to larger guns to get better penetration.[22]

The request for T25s with 76-mm guns also reveals the extent of AGF opposition to the electric drive. The T25 with a 76-mm gun was essentially a T23 without the electric drive. Using the same hull and engine as the T23, the T25 had a larger turret only in order to accommodate the 90-mm gun. Satisfying AGF's request merely involved placing T23 turrets into T25 hulls. If Gen. Barnes had been willing to substitute the torquematic transmission for the electric drive in the T23, as AGF suggested in July 1943, then Gen. McNair's staff probably would have accepted the tank. But the Ordnance Department refused to abandon the electric drive, and this made the T23 unacceptable.

Despite AGF criticism of the armament of the T25, its request was a major victory for the Ordnance Department. Gen. McNair had finally agreed to large scale production for the T20 series. Gen. Campbell had requested only 2,000 to 4,000 of either the T25 or T26; the response from AGF for 7,600 of the tanks must have exceeded his wildest expectations. Since the AGF request had noted that production of M4s should cease as soon as production of T25s could meet operational requirements, McNair had finally found a tank good enough to replace the Sherman.[23] But his views on types and armament met opposition.

Forwarding the AGF request to Maxwell, the War Department's G-4, on 15 April, Clay asked him to solve the problems raised by AGF. He doubted the desirabilty of producing the T25 with 75-mm and 76-mm guns because "The principal superiority of the medium tank T25E1 over the medium tank M4 lies in the increased firepower of the 90-mm gun."[24] Clay also requested Maxwell to decide whether the T25 should replace the M4 and on what basis the T26 should be produced.

Gen. Maxwell quickly settled both issues. He did not believe

that the T25, with or without the 90-mm gun, was convincingly superior to the Sherman. So the T25 would not replace the M4. Influencing Maxwell's decision was the fact that no theater had ever asked for the T25; requests from overseas had only mentioned the T23 (with its electric drive which had not yet satisfied AGF) or the T26. On 17 April, Maxwell met Campbell's minimum demand by ordering Somervell to produce 1,800 T26s armed with the 90-mm gun and 200 more with the 105-mm howitzer. Maxwell discussed his decision with Maj. Gen. Albert W. Waldron, the new Chief of the Requirements Section of AGF, before issuing the directive. Waldron acquiesced pending McNair's approval. McNair reserved final concurrence until he heard from ETO, and Marshall confirmed the decision.[25]

When the theater answered the query on 18 May, ETO's firm requirement for 90-mm guns and 105-mm howitzers finally settled the dispute over armament. Shermans and T26s with the 105-mm howitzer would meet ETO's requirement for that weapon, and the T26 would satisfy requirements for 90-mm guns. McNair still thought that the decision in favor of 90-mm guns was a mistake; but the overseas commanders had made themselves perfectly clear on the issue, and it was now time to carry out orders.[26] Thus McNair's long opposition to the T26 abruptly ended.

The decision in favor of heavier guns illustrates a key feature of the decision-making process for development. There was no rigorous, systematic method for resolving differing viewpoints about new equipment. Even important subjects such as tank armament did not receive a detailed analysis of the technical or tactical issues involved. Rather, Marshall, or usually his staff, took varying opinions into account and then made a decision. The views of overseas commanders obviously carried the most weight. But Marshall neither asked for nor received a detailed justification from ETO about its preferences. In his defense, one should note that the controversy over tank guns must have seemed minor in comparison to problems such as global strategy. Furthermore, Marshall had to retain a broad perspective, which probably took British desires into account.

The British had maintained a close interest in the T26 during the first months of 1944 and asked on 14 March for 500 of the tanks. The War Department responded that approval would be withheld until field tests were complete.[27] But Clay apparently saw no reason for further delay when he had ordered 2,000 tanks without service

tests. On 24 April he directed Campbell to produce 500 additional T26 tanks, raising the total to 2,760, of which only 115 were produced during 1944.[28]

Although the War Department had settled on the T26, the tankers at Fort Knox were still unhappy. The Armored Command realized that there would still be a long delay before the T26 could be of help on the battlefield. It proposed to AGF on 17 April that Britain's Fireflies fill the gap until T26s were in the hands of the troops. Attached ballistic data on the Armored Board letter to AGF showed the 17-pounder's superiority over the 90-mm in terms of armor penetration. Although AGF only wanted to know if the data were correct, Barnes replied on 16 May with a long defense of the 90-mm. Barnes also claimed that the 17-pounder would overload the M4, though the British had never complained about any suspension problems.[29] Barnes's most convincing argument was that it would take at least eighteen months to produce ammunition for the 17-pounder in the United States. But the 17-pounder was never mounted in American tanks in the United States. The tankers were obviously worried by delays in getting better tank guns overseas. An assertion by some of them at Fort Knox in May 1944 that the United States should get a Panther and copy it was a cry of desperation.[30]

While the production decisions were being made, testing of the T25 and T26 continued. It is significant, considering the importance of successful service tests before tanks could be standardized, that the Armored Board did not have a T25 or T26 by 29 April, although the Ordnance Department then had several of them.[31] The faults observed at Aberdeen by Armored Board members were not imaginary. Gen. Barnes admitted the most important of them to ASF on 1 May.[32] By 10 May Ordnance engineers realized that the engine/transmission coupling on both tanks would have to be redesigned; they were still investigating the problem with the brakes.[33] After the Armored Board began testing the T26 at Fort Knox, the tankers' complaints were reaffirmed. On 20 May the Armored Board emphasized that the design should not be frozen for production in its present state.[34]

As testing continued, the planned production of the T26 continued to rise. Apparently to meet ETO's demands for the 105-mm howitzer and British desires for the T26, Maxwell more than doubled the overall figure on 10 June.[35]

For The United States		For Great Britain	
T26/90	2,000	T26/90	750
T26/105	2,788	T26/105	400
	4,788		1,150
Grand Total	5,938		

Numerically, the T26 would be the most important tank produced for the US Army during 1945.

Another part of Maxwell's order was an additional victory for the Ordnance Department. Maxwell waived the weight and height restrictions of AR 850-15 for the T26.[36] The Corps of Engineers, responsible for providing tactical bridges, was the loser. Engineers had labored mightily to provide floating bridges to the Armored Division capable of handling loads up to 35 tons, enough for Shermans. In February 1942 the Ordnance Department assured the engineers that procurement of 35–40 ton tanks was so remote a possibility that it did not warrant procurement or planning of new bridging equipment.[37] Nonconcurring with the Ordnance Committee item that approved the T25 and T26, the engineers pointed out that "there is no standard piece of bridging over which the vehicle (T26) may pass."[38] Further, even when the width of the T26 was reduced for rail shipment by removal of its tracks, there were only certain rail lines with sufficient width clearance. In answering Colby's post-war comment—"Hitler's tanks violated AR 850-15"—one can belabor the obvious by pointing out that German tanks did not have to cross American bridges.[39]

Not surprisingly, the T26 proved a problem when it finally arrived in Europe. But the Chief of Engineers of SHAEF found that the pontoon bridge could be crossed if it were fully reinforced, that the treadway bridge could be used in emergencies, and that a modified Bailey bridge could be negotiated. But the T26 was too wide for movement by railroad.[40] It was necessary to ship special transporters with the tanks. In one of its first actions in combat, the T26 revealed its limitations. Although T26s were present when Americans forced the Rhine River at Remagen, they were too wide to follow Shermans across the Ludendorff bridge.[41]

Soon after this victory over the engineers, the Ordnance Department finally got its heavy tank; at least the Ordnance Committee renamed the T26 a heavy tank on 29 June.[42] Longtime advocates of

the heavy tank, the Ordnance Department actually completed such a tank in December 1941. This tank was standardized in 1942 as the M6. Pres. Roosevelt's expansive order, calling for production of 500 heavy tanks in 1942 and 5,000 more in 1943, probably forced standardization since the M6 was the only contender.[43]

After reaching the Armored Board the M6 proved a technological failure. The Armored Board was not even able to conduct a satisfactory test because the tank broke down so often. Among other things, the transmission continually failed, suspension springs broke easily, bogie wheels wore-out rapidly, and mud compacted in the suspension sufficiently to immobilize the tank.[44]

In spite of all this, the Ordnance Department continuously pressed for mass production and shipment of the M6 to combat zones. As late as August 1944, the Ordnance Department was still trying to send the M6 overseas. By this time they proposed to equip a limited number with a 105-mm anti-aircraft gun. Based on advice from Fort Knox, Eisenhower turned down the M6 in spite of the interest that he had already shown in securing heavy tank guns. The Armored Board had expressed doubt that the M6 would be of any use in combat since it was too heavy to transport and could not be relied upon to arrive at the battlefield under its own power.[45] The M6 might have been a satisfactory fort; as a tank it was a failure.

Its successor, the T26, was already causing some difficulty at Fort Knox. On 30 June 1944, the Armored Board complained of delays in getting spare parts for the tanks being tested there. One T26 had been inoperable for a week, and lack of parts remained a problem for the Armored Board throughout the summer and fall. In September, the Board complained that one T26 had been inoperable for seventy-two out of 109 days.[46] Although AGF protested the delays and ASF admonished the Ordnance Department, the problem was not solved. It is surprising, considering the importance of the service tests to the future of the tank, that the Ordnance Department did not see that they were completed as rapidly as possible. The involvement of major headquarters such as ASF and AGF in such a petty matter as spare parts for an individual tank revealed the increasingly caustic relationship between Gen. Barnes and AGF.

Development of the 90-mm towed gun generated almost as much trouble. The Link-Belt Company had produced a prototype T5 by January 1944 and said that production could begin in June.

But tests by the Ordnance Department revealed some serious defects. New trails and a change in the position of the axle forced a major redesign and a change in designation to T5E1. By May, Link-Belt had delivered another gun to Aberdeen. Discovery of thirty-eight more defects, mostly associated with unsatisfactory recoil characteristics, caused further redesign.[47]

Meanwhile, pressure was building to get the gun into production. Gen. McNair witnessed a demonstration of the T5E1 on 2 May and was apparently impressed.[48] A request for completion of the design and production of 600 guns "at the earliest possible date" followed his visit.[49]

But Ordnance Department officials ignored AGF's desires. In June of 1944 they finally instituted a design program to adapt the T5 for a muzzle brake which had been requested by AGF in November 1943.[50] A dispute arose after McNair witnessed a later firing test that compared the gun with and without a muzzle brake. Ordnance officers apparently believed that McNair had then dropped the requirement for a muzzle brake. AGF clarified this on 14 July 1944. An inter-office comment that "The Ord/Dept alleges . . . the requirement . . . was withdrawn . . ." indicates the acrimonious nature of relations between AGF and Ordnance.[51] In defense of the Ordnance Department, it should be noted that the addition of a muzzle brake to the 90-mm gun tube drastically changed the balance of the weapon and thus the characteristics of the carriage.

All hopes of AGF for early production of the T5 were soon dashed. July tests of the latest version of the gun, without a muzzle brake, revealed serious problems with the carriage. Of some thirty problems, the most serious were a broken axle and cracks in the trails. As a result, representatives of AGF, ASF, and the Ordnance Department met to discuss the future of the T5. AGF reduced their immediate requirement to 200 guns and held production of the remaining 400 in abeyance until a decision could be reached on exactly what type of gun should be produced.[52] Ordnance officers elected to design a completely new carriage.[53]

The problems experienced with the T5 during July 1944 are a good example of the technological pitfalls that plague the development of virtually any weapon. An error in design computation caused the broken axle; the cracks in the trails were due to poor steel. Hurrying to complete the prototypes, the Link-Belt Company used metal from the Inland Steel Company instead of their preferred

supplier, Carnegie Steel. It seems that Inland steel had a lower impact value, making it more brittle than Carnegie steel. The result was cracked trails.

The ultimate result of such problems was a long delay in production. Instead of the Link-Belt Company's optimistic prediction of production in July 1944, production of the final version of the gun, the T5E2, did not begin until December 1944. By the time the towed gun reached Europe no one wanted it.

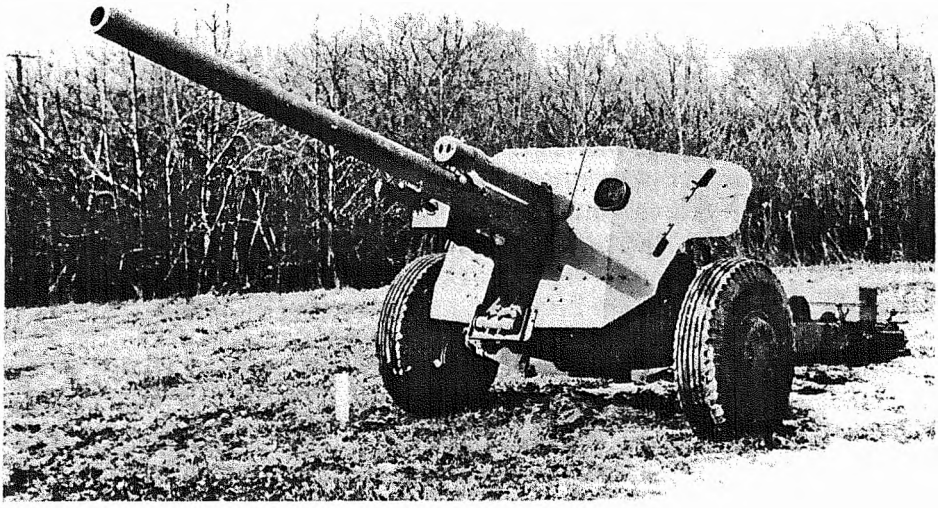


Fig. 20. The T5E2 90-mm gun carriage. Source: *T5 History*.

It is hard to understand why mounting the 90-mm gun on two wheels proved to be such a monumental task for the Ordnance Department. Over two years elapsed before the weapon entered production. Perhaps a lack of emphasis from senior Ordnance officers contributed to the delays. The T20 series of tanks was a matter of almost daily concern to Gen. Barnes but he paid little attention to the T5.[54]

Another significant aspect of the controversy over the T5 was the absence of vocal support from officials of the Tank Destroyer Center, although the T5 was the replacement for the M6 3-inch gun in tank destroyer units. When the M18 was standardized in early 1944, the Tank Destroyer Command had lost most of its interest in

new developments. The M18 was the ideal tank destroyer to the men at Fort Hood, and they expected this to be proven in combat. So far as they were concerned, there was no need to go further, and they spent their time refining what they had. The Tank Destroyer Command tested the T5, but its intense interest in development was gone. It was probably just as well because AGF needed no help from Fort Hood to find fault with the Ordnance Department.

AGF fought still another major battle with the Ordnance Department and War Department during the summer of 1944. An Ordnance proposal that had appeared in January finally died on 18 August when Gen. Maxwell ruled that no test platoons of T25s and T26s would be sent to NATO. This idea had appeared in a letter from Barnes to Devers. Gen. Barnes mentioned possible tests of the T23, T25, and T26 tanks in NATO.[55] Worried about getting larger production orders for the T20 series, Barnes apparently believed that combat tests would establish a larger demand. Barnes was sure that tankers would be enthusiastic about the new equipment if they saw it demonstrated in combat. Gen. Devers was the obvious choice for the enterprise, since he had been instrumental in obtaining the first large production orders for T26s. Once again, Devers did not disappoint Barnes. On 17 February, Devers requested the War Department to send one T26 and enough T23s and T25s to equip platoons or companies.[56] He also wanted to know how soon the tanks would be available. Gen. Campbell wired on 6 March that five T23s, five T25s, and one T26 would be available about 1 April.[57] After Devers's encouragement, Campbell proposed to ASF on 13 March that the tanks be made available to NATO with an accompanying technical team.[58] On 14 March, AGF disagreed. No service board had tested the tanks and it was "not known whether they are fightable and fit for combat." AGF did agree to expedite service tests. If the tanks proved to be "generally satisfactory for combat," it would go along with Campbell's idea. "This headquarters," AGF also remarked, "does not view with favor the idea of making any combat zone a testing agency."[59]

Gen. McNair's policy was that even after a piece of equipment proved capable of performing the function for which it was designed, it must still be reliable enough to withstand the rigors of combat without excessive maintenance. He adhered to this standard of "battleworthiness" throughout the war. In addition, AGF steadfastly supported the principle that no equipment should be issued to

theaters until it was tested in the United States and had met AGF's "battleworthiness" standards. McNair was determined that no "ground soldier be exposed to the unnecessary hazard of using unproved equipment, however promising it might look."[60]

Pending clearance from AGF, Gen. Somervell stopped the shipment of the new tanks on 31 March. He wrote:

> This Headquarters favors the early introduction into combat theaters of new equipment and particularly that involving long production cycles . . . [But] before such equipment is introduced into theaters, it is essential that the using force be given an opportunity to evaluate the equipment and reach a finding that it is fightable and generally satisfactory for combat as indicated by the Commanding General, AGF.[61]

But the idea itself was not yet dead.

After receiving notice of the shipment's cancellation from ASF on 7 April, Devers replied on 18 May he still wanted battle tests for the T20 series of tanks.[62] Before Devers reaffirmed his request, Marshall, while at Aberdeen Proving Grounds, had directed Maj. Gen. Stephen G. Henry, New Developments Director at the War Department, to "follow up" on the T23. Henry replied to Marshall on 13 April that the T23 had entered production in March. "Theater Commanders," he pointed out, "generally have not looked with favor upon re-equiping existing units with newly developed types of combat vehicles."[63] In addition, Henry mentioned that most of the T23s would go into storage pending service tests by a tank battalion. Marshall annotated the memo, asking if Henry agreed with the theaters and the idea of storing 175 T23s. His answer on 17 April expressed his agreement with the decision not to send untested equipment overseas; T23s should be stored until tests were completed. Relating a conversation with the AGF commander, Henry stated that "I have personally talked to Gen. McNair . . . and he is of the opinion that the T23 in its present form should not be shipped to an active theater. In this I fully concur."[64] Maj. Gen. Thomas T. Handy, head of the Operations and Plans Division (OPD) discussed the subject with Henry, Barnes, and Campbell. He advised Marshall on 23 April that he did not believe the T23 should be sent overseas since testing could be conducted faster in the United States. Gen. Marshall agreed.[65] Although the T23 would remain in the United

States, Marshall asked Devers if he still wanted the T25 or T26, advising him that a platoon of T25s could be available in August and one of T26s in December.[66] Gen. Devers reiterated his request on 6 June.[67]

Since Devers still wanted the tanks, Gen. Maxwell ordered Somervell and McNair on 10 June to organize and dispatch one platoon of T25s and another of T26s to NATO as soon as the platoons were available. AGF objected to the directive, emphasizing that all available T26s were needed for testing in the United States and adding that the T25 needed modifications before being shipped overseas. A representative of ASF pointed out that modifications of the T25 would require use of the same facilities that were presently being prepared to produce T26s, thus disrupting production of the T26. Maxwell stood firm and overruled AGF and ASF on 5 July. He directed the T25s to be taken from the forty then available, with only local modifications, and the T26s to be obtained from the production line.[68] Emphasizing the directive on 31 July, Gen. Handy advised Somervell and McNair to have the platoon of T25s ready for shipment by 5 September.[69]

Despite the vigor with which Maxwell pressed the idea of test platoons, the project had no future. On 18 August Maxwell rescinded his previous directives, citing only the status of production of the T26, and changing theater requirements. He advised Devers that he would receive T26s in accordance with his theater's priorities.[70] Probably Maxwell realized that diverting T26 tanks in December to Devers would necessarily mean taking them from Eisenhower, who had recently demanded more 90-mm guns. The decision to withhold the T25 was probably based on Maxwell's previous refusal to produce the tanks for AGF. Since the tanks were not to enter mass production there was little point in testing them overseas. Experience with the T25 and T26 at Fort Knox would indicate that Maxwell's decision was fortunate.

After receiving a request from AGF to express its views concerning the overseas tests of the platoons then being organized by the former, the Armored Board objected strongly to the entire project. Col. Williams noted that the Board "could not concur in the combat test," and flatly stated that "Medium Tank, T25E1, is so mechanically unreliable as to practically assure its inability to carry out combat missions." He noted that the T25 was "an inefficient combat vehicle" because of faulty provisions for stowing ammuni-

tion. Further, Williams pointed out the disaster which might ensue should one of the tanks be captured by the Germans. Such an event had "an excellent chance of happening due to the vehicle's mechanical unreliability. . . ."[71] Of course, when any new tanks are sent into combat some will inevitably be captured. But waiting until the tank can be used in large numbers gives the enemy no time to capitalize on the information before the new tank can make a major impact in battle. Williams pointed out that the secret features of the T25 and T26 might be revealed months before significant numbers of the tank reached combat.

Although the objections of the Armored Board probably had no impact on Maxwell's decision, they were certainly important to yet another dispute between AGF and the Ordnance Department. The Ordnance Department proposed on 31 August that the latest version of the T26 be standardized. This weapon, the T26E3, incorporated corrections for all the deficiencies identified during the summer tests. AGF raised several objections to standardization, primarily that no modified tank had yet been tested at Fort Knox and that the tests of the original T26 were not yet completed. Additional modifications might be necessary and thus standardization would not facilitate production.[72] Experience with the M18 supported this conclusion. AGF won this battle, and the T26 was not standardized as the M26 until March 1945 after service tests were completed. But standardization of the M26 did not provide a new medium tank to replace the M4.

The failure of AGF to persuade Maxwell to order production of T25s and the classification of the T26 as a heavy tank (this classification was revised back to medium after the war) left AGF with no medium tank under development, and the Sherman was becoming obsolete by anyone's standards. Of course, neither the Armored Center nor AGF had ever been totally satisfied with the T20 series, which was the Ordnance Department's inspiration. To rectify this situation AGF decided to generate its own requirement for a new medium tank.

After coordination with Fort Knox, AGF submitted detailed specifications to ASF on 6 December 1944. Admitting that the project was long range, AGF asked that the Ordnance Department complete a design study of the vehicle to provide a basis for a conference to settle any problems.[73] Barnes's office disdainfully rejected the project, claiming that the result would be a 60-ton tank,

not the 45-ton tank specified by the proposal.[74] Colby called the proposal "amateurish."[75] It might have been, but Ordnance officers would not even condescend to do the design study.[76]

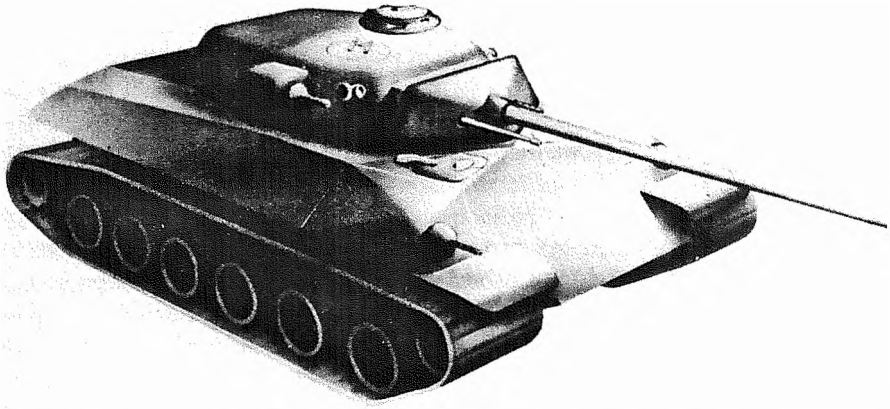


Fig. 21. Artist's conception of the AGF Tank. Source: Specifications attached to letter from HQ, AGF, to CG, Armored Center, 28 September 1944, *AGF (470.8)*.

It is difficult to consider the proposed tank without a design study, but the weapon does not seem to have been all that bad. The Ordnance reply stated that the large weight would result from "increased bulk requirements due to the demand for increased power, cruising range and larger diameter turret ring . . ."[77] AGF did not specify power requirements but asked for an 8-inch armor basis and 20 mph sustained speed. The proposed cruising range was only 100 miles, but the 80-inch diameter of the turret ring was an advance on the 69-inch ring of the T26.[78] Although AGF's tank was never built, the Russians managed to build a thickly armored tank with a large turret ring, the T54, which weighed only 40 tons. Some of the characteristics of the proposed tank would undoubtedly have had to be compromised, but it had a more important fault.

Like the M7, the AGF tank represented a lack of vision. Armored officers must have had the 17-pounder or German Kwk. 42 in mind when they specified a gun with a maximum caliber of three inches to penetrate eight inches of armor or the equivalent thickness of slanted armor. If the US Army had been willing to embark on this project so late in the war, and if Congress had been willing to fund its post-war completion, the result would have been yet another poorly

armed tank. It could possibly have been completed in 1948 or 1949, but by then its 76-mm gun would be too small in comparison to the 100-mm Russian or 84-mm British developments of that period. In essence, the AGF tank was a heavily armored and well armed "Super Sherman." If it could have magically appeared in 1944, it would have been fine. As a long range development it went nowhere.

But before the AGF tank became a matter of debate, there were still more differences between AGF and the Ordnance Department over the T26. The disputes over the T26 continued when the tank finally entered production in November. To facilitate service tests and release of the T26 for overseas shipment, AGF requested on 19 October that the first twenty tanks off the production line be sent to Fort Knox. On 24 October ASF ordered the Ordnance Department to comply with AGF's desires.[79] By 8 December, Barnes was upset with the directive because he believed that it would delay the shipment of the tank to ETO. He convinced Maj. Gen. William A. Borden, who had replaced Henry as New Developments Director in the War Department, that tanks eight through twenty-eight should be shipped directly overseas. Borden then managed to sell the idea to Maxwell. The G-4 called a meeting between himself, Barnes, Borden, and Waldron of the Requirements Section of AGF in which Gen. Barnes and Borden presented the Ordnance Department's viewpoint. Apparently, Maxwell had already made up his mind, and he overruled Waldron.[80] AGF received only the first seven tanks.[81] Maxwell noted that the tanks were being released without AGF's approval and partially mollified Waldron by adding a member of the Requirements Section to Barnes's technical mission that would accompany the tanks to Europe.[82]

The Zebra Mission, headed by Barnes, was intended to expedite the introduction of the T26 into combat units. Single items of other new equipment, including a T5E2 gun, were also part of the mission. But the trip also served as a promotional effort for Barnes. Arriving in Paris on 9 February 1945, Barnes quickly made contact with representatives of SHAEF, who arranged a meeting with Gen. Eisenhower. The Supreme Commander decided to send the twenty T26s to Bradley's 12th Army Group, and Bradley's headquarters subsequently assigned them to the 3rd and 9th Armored Divisions of the First Army. Apparently unable to ignore a chance to vindicate the time and effort spent on the T23, Barnes managed to have this tank introduced into discussions with Eisenhower. The Commander

of SHAEF referred the matter to Holly's Section. "All Commanding Generals," claimed Barnes, "stated they would be very glad to have these tanks with 76-mm guns . . ."[83] However, Col. Dean, the representative from AGF, put forward a directly contrary report.[84] Gen. Holly commented that "It is unlikely that the 'Commanding Generals' referred to have a personal knowledge of the problems associated with the introduction of the electric drive T23; their expressed desires were very probably based on the 76-mm gun with which these tanks are equipped."[85]

Pressure for more 76-mm guns was intense by 1945. Troops and commanders agreed that they wanted no more Shermans with the 75-mm gun. Ordnance units in the theater managed to devise a way to replace the 75-mm gun in the Sherman with the 76-mm. This was the same way that the Ordnance Department had first mounted the bigger gun in the M4, and the Armored Board had rejected it in 1943. When there was no pressing need for the 76-mm gun, such an improvisation was unacceptable; but when representatives of the Army Groups viewed the modified tank on 24 February 1945, they deemed it a "satisfactory expedient." After combat created a desperate need for a better tank-destroying weapon, the unsatisfactory became satisfactory. The small number of guns available and time consumed for the conversion (150 man-hours) combined to kill the idea. Only "Jumbos" received 76-mm guns because troops had learned to appreciate their thick hides and its conversion was easier.[86] Even this intense desire for 76-mm guns could not persuade Gen. Holly to recommend that the theater should request T23s.

Despite Holly's distaste for the T23, Eisenhower required his tank specialist to study the advisability of introducing T23s into ETO. When tests of the T23 had been completed, AGF requested on 22 November 1944 that T23s be modified to correct all deficiencies identified in these tests, and then tested again. AGF proposed offering two battalions to ETO or Mediterranean Theater of Operations (MTO) if the tanks proved successful. Gen. Barnes objected on 19 December that modifying the T23 would interfere with current tank production. "Furthermore," Barnes testily commented, "the modifications would require so long a time that any opportunity to employ the tanks in this war would have been lost." He recommended sending the entire 250 tanks overseas "as is" to gain experience with the electric drive.[87] Supporting Barnes, Campbell recommended to Somervell on 30 December that 250 T23s be sent to

ETO. Campbell must have been embarrassed when Somervell discovered that there were only 147 T23s available for issue. The idea was killed by the Operations Division of the War Department.[88] After reviewing this information and a copy of the Test Board Report which opposed sending the T23 overseas, Holly recommended to Eisenhower that the T23 not be requested for ETO. Eisenhower agreed in February 1945.[89] This finally ended efforts to send the T23 overseas.

Despite AGF's efforts to test the T26 thoroughly, the tank still had faults when it arrived in Europe. For example, when the gun was cold it would not recoil far enough to eject expended shell casings. This problem resulted because the muzzle brake, insisted on by the Armored Board to reduce blast, also reduced recoil. Ordnance engineers neglected to change the cam which operated the gun's breech to compensate for reduced recoil. Luckily, one of the technicians with Barnes was able to solve the problem in the field by filing down the cam.[90] The fact that the T26 suffered relatively few teething problems in the field is a tribute to the thorough testing insisted upon by Armored and AGF officers. Yet only 200 of the tanks reached the troops by the end of the war.[91]

Nonetheless, overseas commanders were enthusiastic over the T26. American tankers proved to be quite happy, particularly because of the tank's 90-mm gun. Reports of the T26 were mainly distinguished by noting how many German tanks were destroyed by the new American vehicle. Gen. McNair was right. A big gun on a tank encouraged crews to hunt other tanks. He would have been appalled to learn that when the troops received a T26 with a special high velocity 90-mm gun, the tankers immediately welded more armor on the tank and went off looking for a Royal Tiger.[92]

Besides his attempt to sell the T23, Barnes also touted other projects. "All Commanders of Armored Divisions," he reported to Campbell, "thought that the heavy tank T26E3 represented the ideal type of tank . . ." After displaying a packet of photographs of new heavy tanks—the T28, T29, and T30, which were all matters of controversy with AGF—Barnes assured Campbell that the tankers were begging for the vehicles with comments such as "T28 . . . good tank, T29 . . . will be well received, and T30 . . . thought to be ideal . . ." Characteristically, Barnes recommended production of 500 T30 tanks (155-mm gun).[93] He returned to the United States in March, glowing with satisfaction. As he departed, the burning

controversy over tanks began to disappear from the pages of public news and became history.

The development process had provided the tank destroyers with both the weapon that they desired and another fostered by the Ordnance Department. Gen. Bruce had fought hard for his M18, the "ideal" vehicle for tank destroyer doctrine, and the troops regarded it highly. But the fighting men were much more avid for the M36, which McNair and the Ordnance Department had forced on Bruce, because it had the firepower so desperately needed to cope with Panthers and Tigers during the Battle of the Bulge.

Towed tank destroyers died after failing the test of combat, and self-propelled ones did not survive long after. As officers of ETO studied their combat experience after the war, they found that tanks, which had become as well armed as tank destroyers, were able to do anything that tank destroyers could. Therefore, ETO's General Board concluded that the tank destroyers' function be assumed by tanks and "that tank destroyers as a separate arm be discontinued."[94] The War Department agreed and disbanded the tank destroyers.

Development of tanks had produced more controversy than had tank destroyers, but the results were less happy. Neither the Ordnance Department's nor the Armored Force's products were of any value to the men in combat. The twenty tanks that Barnes so proudly chaperoned to Europe were far too little and much too late. After wasting time on the M7 the Armored Force tried to have the Sherman adequately armed. But the Ordnance Department scorned interim measures such as the Firefly or an M4 with a 90-mm gun. Gen. Patton probably summed up the attitude of the troops best when he told an Ordnance officer that "Ordnance takes too God Damn long seeking perfection at the expense of the fighting men and you can tell that to anyone at Ordnance."[95]

Conclusion

Stung by criticism of correspondence and tankers about the belated arrival of the T26, Ordnance officers and subsequently the official historians of the Ordnance Department sought an explanation. His steadfast and vocal opposition to production of the T26 in the fall of 1943 made the late Lesley J. McNair a perfect scapegoat. His success in keeping such tanks as the M6 and T23 off the battlefield and the acid disputes of 1944 confirmed the bitterness of the Ordnance Department. Close association with these men and their records led the official historians to place the blame for the slow arrival of the T26 on McNair and AGF. A fresh reading of the evidence suggests that the Ordnance historians were mistaken.

Gen. McNair's opposition to production of the T26 did not delay the arrival of that tank in Europe by a single day. AGF consistently supported development efforts and approved production of ten T26s in May 1943. The nine months that elapsed before the Ordnance Department managed to build the first T26 were not the result of AGF interference. McNair's firm stand against producing extra T26s in the fall of 1943 had been overruled by Marshall only three months after the Ordnance Department first recommended production. Before the first prototype of a T26 had moved a track block, the Ordnance Department had orders for 300 of the tanks. These tanks did not begin arriving on the battlefield for fourteen months. In 1943 the tank existed only on paper. Furthermore, the original T26 had serious deficiencies that had to be corrected during the summer of 1944 before the tank was ready for combat. AGF did not invent those deficiencies. McNair supported efforts to perfect the T26 and, in fact, came to the rescue when Campbell wanted a large production order in 1944.

Lida Mayo supports Colby's assertion that the T26 could have

been ready for the landings in Normandy had it not been for McNair's opposition. This appears highly doubtful. Even taking the most optimistic viewpoint for the Ordnance position that the tanks could have been ordered in September 1943, the fourteen months that proved necessary to get the tanks to Europe would have resulted in the arrival of the T26 no earlier than November 1944. The Ordnance argument assumes that an early production order would have resulted in the rapid arrival of the T26 in combat. This assumption is not supported by experience with any other tank produced by the Ordnance Department.

Even the Ordnance Department's fastest development, the M18, does not support this optimistic assessment. The M18 had been in development nearly a year before AGF asked for mass production in February 1943, which began in July. By February 1944 only 103 M18s were fit for combat, and they were still in the United States. It took more than a year to get M18s to the front—and then in small numbers.

The delay in fielding the T26 was due to something far more deep-seated than the colorful dispute over production orders in 1943. It takes time to perfect major technological developments. This was true for the T26. It did not appear earlier because the engineers in the Ordnance Department could not construct a satisfactory version of the tank any faster than they did. The only factor that might have helped would have been early and continuous participation from the Armored Board. Such coordination might have eliminated some of the T26's faults before its prototype was completed. Perhaps a few months could have been saved. But this is not to say that the development of the T26 was anything less than a very respectable accomplishment. Only thirty-two months elapsed between the mock-up M4X and the arrival of T26s in Europe. The vaunted Panthers arrived in battle after only eighteen months, but twenty-eight months transpired before the Germans considered the tank satisfactory in March 1944.

The German Army was about one to two years ahead of the US Army in tank designs. That lead did not result from advances after 1942; it probably resulted from developments during the inter-war years. From 1935 onward, the Germans began developing a technological base for tanks; meanwhile the Ordnance Department struggled to squeeze money from a government trying to cope with the worst depression in American history. The various components that

were assembled to create the Panther were therefore under development during the pre-war years. Combat experience prior to American entry into the war spurred the tank toward completion.

In contrast, the T26 was a pioneering effort for American tank designers. Its torsion bar suspension, box hull, rear drive, and torquematic transmission were all new. Some of these features, in particular the box hull and rear drive, are now present on modern tanks such as the Russian T-72 and British Chieftain. Perhaps the best epitaph for the T26 is that it served as the basis for the M60 tank, standard equipment over thirty years later.

But disagreeing with the official histories and defending the T26 does not address the fundamental issue. During 1944 and 1945 American soldiers found their weapons inadequate to deal with German tanks. The reason for this was a combination of two factors: doctrine and knowledge of the enemy. Doctrine dictated that American tanks should not be armed to fight other tanks. A poor evaluation of the enemy coupled with very limited experience in fighting his tanks provided no reason to change doctrine.

The failure to assess the capability of American guns to deal with German tanks lies largely with the Ordnance Department. That agency was responsible for technical intelligence. It did not discover how weak American weapons were until it was too late to develop adequate ones. The rest of the US Army was equally tardy in calling for a re-evaluation. There was no significant complaint from the men in the combat zones until July 1944. Given Gen. Marshall's willingness to answer demands from his theater commanders, there is no doubt that changes would have occurred if they had been requested. More particularly, the Tank Destroyer Command must share the blame for the poor assessment of German tanks. The US Army's primary agency for coping with German tanks should have left no stone unturned to be positive that their weapons would be adequate for the task. But it remained complacent, never questioning the capability of the 76-mm gun. As a result, only a limited number of 90-mm guns was available. Even these were not fully adequate, and none of them were on tanks, which were the vehicles most often at the forefront of battle.

There had been no reason to change the doctrine that kept well armed tanks off the battlefield. The US Army's first experiences in combat seemed to confirm it. Battle experience in North Africa indicated that guns were the answer to tanks, but experience also

indicated that those guns should not be mounted on vehicles. The US Army did not learn that its tanks needed better armament until the summer of 1944. Another lesson of that summer was that the towed gun was a failure in different circumstances. These are clear illustrations of the hazards of combat "lessons" which are so often hastily drawn and dependent on specific terrain.

The fate of the towed gun was a part of the failure of the tank destroyer concept. When Gen. McNair conceived the idea, anti-tank guns were light and easily moved, perfectly adaptable to his idea of easily massed mobile guns. Their small size also allowed them to be easily concealed and thus more dangerous to tanks which had to expose themselves in order to attack. By 1945 the little 37-mm gun, whose 912 pounds could be easily handled, had grown to a cumbersome 90-mm, 7,800 pound monster as hard to conceal as to move.

The concept was not necessarily misguided. Technology of the 1940s could not provide small weapons to defeat increasingly heavy tanks at practical ranges. Technology has now provided such a weapon, the guided, anti-tank missile of the 1980s, and a means to give it great tactical mobility—the helicopter. In this context, McNair's concept may not be an idea whose time had come and gone, but one that could not be supported by the technology available at the time.

The story of the tank destroyers provides a fascinating juxtaposition of personalities, doctrine, technology, and combat experience. At various times each of these factors seemed to be the decisive one, but invariably the remaining factors always affected results.

Initially the combat experience of the French and British forced a doctrinal change. In 1940 and 1941, the problem of stopping German tanks was doctrinal, not technological. In 1940, every modern army could destroy a tank. The new problem was how to cope with the German doctrine—massed tanks. America's answer was massed, mobile anti-tank guns. This doctrine demanded that technology provide suitable weapons. Since technology could not immediately provide those weapons, the executors of the new doctrine were told to adapt their tactics.

Experience in North Africa forced doctrine to accept towed weapons. This event involved Bruce in a technological development effort that he did not desire—the M10. Meanwhile, he waited for technology to provide the M18, which was needed to execute his doctrine properly. Further, the enemy's technological threat forced

him to accept the development of even heavier weapons such as the M36.

Technology played a major role in the demise of the tank destroyer. Heavy German tanks forced the United States to produce heavy anti-tank guns. Since large caliber towed guns proved to be a failure in combat, the guns had to be mounted in vehicles which grew to cope with the guns. The light, fast M18, Bruce's technological solution, was poorly armed by 1945 and could not carry a larger gun while retaining its mobility. The remaining tank destroyer, the M36, was hardly distinguishable from a tank and just as expensive. Its only advantage was the 90-mm gun which had already appeared in a tank. In effect, the tank destroyer became a hybrid tank, undesirable when the real thing was available. Technology could not provide adequate firepower on a vehicle fast enough to employ tank destroyer doctrine or to have any tactical or economic advantage over a tank. But technology was only part of the reason that the Army abandoned tank destroyers.

The most fundamental problem of the tank destroyer units was that they were a defensive organization in an army almost continuously on the offensive. They rarely faced the enemy they were designed to meet because the German Army had spent its offensive power in Russia as the tank destroyer units and weapons were being developed. Of course, neither Marshall nor McNair could know in 1941 or 1942 how profligately Hitler would squander his Panzers on the Eastern Front. The result was that tank destroyers were eventually measured by their ability to participate in offensive actions as a substitute for artillery or tanks. Not surprisingly, they were not as good as units trained and equipped for those tasks.

Despite their deficiencies, it does not follow that creating the tank destroyers was a costly mistake. Their presence on the battlefield gave the US Army a large number of effective anti-tank guns long before those guns were or could have been available in tanks. Without tank destroyers losses to German tanks would have been worse. The costly mistake was the failure of US Army leadership to realize that the tanks of an offensive army would inevitably be forced to deal with the enemy's armor. And it would not have required the abandonment of the tank destroyer's never tested doctrine to put a 90-mm gun in the Sherman tank.

This author is compelled to agree with Lida Mayo that the failure to provide a heavier gun for the Sherman was unfortunate. Of

course, McNair was chiefly responsible for killing Gillem's proposal; but the Ordnance Department is certainly not blameless, and the lukewarm attitude of the overseas commanders to the 90-mm gun was no help. Given McNair's permissive attitude toward development, it was probably unfortunate that Gillem asked for immediate production instead of development. A 90-mm turret for the Sherman might have been ready to go into production in the spring or summer of 1944 when Eisenhower finally asked for the gun.

Finally, it may be useful to make some assessment of the involvement of senior commanders in the development process. As the story of tank and tank destroyer development unfolds, it is difficult to see who was in charge. There was a definite lack of a thorough grasp of tank or tank destroyer development at the highest levels in the US Army. Gen. Marshall was aware of the serious controversy as a result of the dispute over production of the T26 in the fall of 1943. In retrospect, it may be surprising that he did not try to assemble all the interested parties and settle that important issue. But his consciousness of the need to meet the desires of the theater commanders in a global war may have made him reluctant to act on a problem in which the theater commanders had little interest. Eisenhower was surprised by First Army Tests in July 1944, though his own staff had enough information before D-Day to warn him that there might be a problem.

Few of the senior commanders were technologically-minded. Men such as Eisenhower, Marshall, and McNair had entered a mostly horse-drawn or foot-propelled army that had done well in World War I by relying on French and British technology. Further, their education in US Army schools after the war emphasized production rather than development. All this probably combined to make them less sensitive to technological problems, as distinct from industrial problems, than we are in the latter half of the twentieth century. Their subordinates were little better. That such a resourceful tanker as Ernest Harmon—who believed that firepower was the first priority of tank design—was not curious enough to conduct his own firing tests in 1943 is symptomatic.

The problems associated with rapid expansion of a small professional army into one capable of fighting a global war forced a very able group of generals, largely by default, to turn over the responsibility for technological development to subordinates. The expansion of the US Army was so fast that the selection of those subordinates

had to be based on close personal knowledge of their talents and abilities. Those selected were, in general, stubborn visionaries who did very well at many wartime tasks where leadership and decisiveness were more important than technological expertise. Overall, this system of personal command succeeded, although it was inefficient at developing equipment. For instance, Jacob Devers's questionable decisions concerning tank development hardly tarnish a reputation based on solid achievements of organization, training, and combat command.

The high command was not aided by its decision-making process. Decisions were usually based on opinion—not on detailed analysis of the facts. For example, none of the requests from ETO were supported by a detailed justification based on factual data. Opinions ruled and those of overseas commanders whom Marshall had personally selected carried the most weight. In defense of the process, it should be noted that global war offered little time to gather information or prepared detailed studies. Even an increased use of scientific evidence would not necessarily have worked. When soldiers turned a technological problem over to the scientists, the latter sometimes produced false solutions—as they did when determining the ability of American guns to penetrate German tanks. During World War II, neither scientists nor soldiers were educated to communicate clearly to one another. But in retrospect, it seems clear that the process could and should have been more systematic than it was.

The lack of concern about tank development may have been justified. After all, the US Army never suffered a major tactical reverse because of the quality of its tanks or tank destroyers. The Shermans and M10s usually had numbers, airpower, and superior artillery. Gen. Devers was right—the Sherman did the job. We won the war with the M4. But in northwest Europe in 1944 and 1945, particularly in the snow-clad forests of the Ardennes, the American citizens who manned the Army had to pay in blood for the US Army's failure to provide them with better weapons.

Appendix 1
Technical Explanations[1]

United States Tank Classification

United States tank classification was originally designed in terms of approximate weight: 15 tons—light, 30 tons—medium, and 60 tons—heavy. Although this general scheme of classification did not change, weights varied widely for different types of tanks; indeed, light tanks may have weighed anywhere between 9 and 24 tons. As the war progressed, classification gradually came to indicate function rather than weight. Light tanks were used for reconnaissance purposes. Medium tanks were used as the main equipment for armored divisions, i.e., to exploit breakthroughs. Heavy tanks were envisaged to serve as infantry support tanks; but since the United States produced almost none of these tanks, mediums actually filled this role in battle. In effect, light tanks served a limited role, and medium tanks became general purpose tanks. Foreign classifications were similar to those of the United States, although their terminology sometimes differed.

United States Tank Designations

When design of a tank started it was given a "T" (test) number, such as T26. After prototypes for the tank were tested by the Ordnance proving ground for engineering purposes, they were tested by the service board of the branch of the US Army that had primary interest, a "user" such as the Armored Board. The Boards tested the tank for tactical suitability and suggested any necessary modifications. If the tank was needed and had proven satisfactory during tests, it was *standardized*. This meant that the War Department approved the tank for production and issue to US Army units.

After standardization, the tank received an "M" (model) number, which was not always the same as the "T" number; for example, the T6 became the M4. Modifications of the standard tank were indicated by an "A" suffix; for example, the M4A3 was the M4 with a Ford V-8 engine. Lesser modifications sometimes called for an "E" suffix; hence the M4A3E8 represented the M4 with Ford engine and horizontal volute spring suspension. Adding to the confusion, different types of guns in any given tank did not necessarily get an "A" or "E" suffix. For example, if an M4 carried any gun besides the 75-mm, this was indicated in parenthesis [M4 (76-mm)].

United States Tank Names

Names for tanks came from the British and were never official in the Army. However, American soldiers and correspondents commonly used the British names, e.g., Sherman, Grant, Stuart.

Tank Destroyers

The name "tank destroyer" applied officially only to the organization. The vehicles were properly called Gun Motor Carriages, but commonly referred to as tank destroyers or TDs. Some correspondence uses the confusing term "towed tank destroyer" which refers to a towed gun. The system for applying "T" or "M" numbers was the same as that for tanks. One confusing fact is that model and test number were designated for every type of equipment independently of other types of equipment. For example, there was an M6 heavy tank, an M6 gun motor carriage (the Fargo), and an M6 3-inch gun. The system would have allowed an M6 90-mm gun and M6 76-mm gun. Tank destroyers also received British names, such as Wolverine for the M10, but these were rarely used by Americans.

United States Tank and Tank Destroyer Guns

The most common gun used on American tanks was the 75-mm, which was designed to fire ammunition for the American version of the French "75" of World War I fame. A lighter version of the 75-mm, which used the same ammunition, made possible by

improved metallurgy was fitted to some light tanks. In addition, the 75-mm pack howitzer was adapted for use in armored vehicles, but it could not fire the ammunition used in the 75-mm gun.

Tank destroyers were most commonly equipped with the 3-inch gun, an adaptation of a pre-war anti-aircraft gun. A lighter version of the 3-inch gun, the 76-mm, had the same projectile and performance but used different ammunition. The 76-mm gun was fitted in some tank destroyers and Sherman tanks.

The 90-mm was also an adapted anti-aircraft gun. However, since it was a later design than the 3-inch gun and had already used improved metallurgy, no light version was built. The Ordnance Department built and tested several high performance versions of the 90-mm, but none were numerically important.

A lightweight version of the 105-mm howitzer used by paratroop units was adapted to fit tanks and employed in combat mounted in M4 tanks. Howitzers are low velocity, high trajectory cannons used to support infantry. In addition, the 105-mm anti-aircraft gun was fitted to a few experimental tanks. The 105-mm gun was vastly bigger and heavier than the howitzer; the two should not be confused.

British Tank Guns

In general, the British adapted their anti-tank guns to equip their tanks. Terminology of British guns was confused by the use of the traditional method of naming a cannon according to the weight of the projectile. The 2-pounder (40-mm) was approximately equivalent to the American 37-mm gun and was, like the American gun, obsolete by 1942. Replacing the 2-pounder, the 6-pounder entered service in 1942, and the United States adopted the gun, naming it the 57-mm anti-tank gun. British tank and anti-tank guns lacked high-explosive ammunition, a severe tactical disadvantage. Therefore, much impressed by the American 75-mm gun, the British adapted it to fit existing 6-pounder mounts for tanks and fire American ammunition. The British used the 75-mm only in tanks and, adding to the confusion of terminology, called it the 75-mm. The best British anti-tank gun, the 17-pounder (76-mm), was heavier than the American 76-mm, but it was able to penetrate thicker armor. However, the 17-pounder lacked high-explosive ammunition until the last months of the war.

German Tank Nomenclature

The following translations should be helpful:

Ausfüehrung	modification
Fliegerabwehrkanone (Flak)	anti-aircraft cannon
Kampfwagenkanone (Kwk)	tank cannon
Panzerkampfwagen (Pz. Kpw. or Pz.)	tank
Panzerabwehrkanone (Pak)	anti-tank gun
Sonder Kraftfahrzueg (Sd. Kfz.)	particular motor vehicle

German tank models were initially numbered by Roman numerals such as *Panzerkampfwagen* IV. However, the Allies commonly used the term Mark instead, and this term is habitually employed in English language books. Mark numbers do not necessarily indicate any classification of a tank or its chronological relationship to other tanks. For example, the Mark VI was a heavy tank introduced before the Mark V medium tank. Germans also used modification *(Ausfuehrung)* letters to distinguish tanks of the same model series. *Ausfuehrung* designations were usually ignored in Allied correspondence. As the war progressed, the German Army began assigning official names to new tanks. The definitive numerical designation of German tanks was their Ordnance number, (Sd. Ktz.), but this was almost never used in Allied correspondence.

The designations of the later German tanks were particularly confusing. The Tiger (Mark VIE) was introduced before the Panther (Mark V), after which the Tiger II (Mark VIB) was introduced. In addition, the numerical designations of the two Tiger tanks indicates that they were different versions of the same tank, and yet they were totally different designs.

German Tank Guns

German tank cannons generally used only a few calibers, but those calibers represented several different cannons. For example, there were three different 75-mm guns. The Mark IV originally carried a low velocity 75-mm gun. In 1942 the Germans fitted a 75-mm gun with a longer barrel (Kwk 40) on the Mark IV and other armored vehicles. The 75-mm Pak 40 and 75-mm Kwk 40 had the same performance but used different ammunition, as was the case

with several American weapons. The Germans introduced yet another 75-mm gun in the Panther, the Kwk 42. The Kwk 42 was heavier than the Kwk 40 or the Pak 40, and its armor penetration performance was markedly superior to the smaller guns.

Newspaper columnists and some of the official historians seem to be confused about the other major German tank/anti-tank gun, the 88-mm. They generally compare the American 90-mm to the German 88-mm without mentioning that there were two quite different 88-mm guns. The 88-mm Flak 36 (Kwk 36) was slightly inferior to the American 90-mm, but the 88-mm Flak 41 (Kwk 43) boasted a higher muzzle velocity although it weighed more. However, the earlier Flak 36 was far more frequently encountered by Allied troops than the Flak 41. The tank version, the Kwk 36, equipped the Tiger I. Only about 1,000 German armored vehicles (total production of the Tiger II, JagdPanther, and Rhinocerous) carried the Kwk 43 while 1,350 Tiger Is with the older Kwk 36 were produced. Both the Flak 36 and Flak 41 were anti-aircraft guns that were employed as anti-tank weapons. The Flak 41 was adapted to an antitank mount, becoming the 88-mm Pak 43, but the Flak 36 was continuously employed in its anti-aircraft form. Clearly, news correspondents were questionable sources for technical data.

Appendix 2
Technical Data

This appendix is intended to provide the reader with a reference for the technical characteristics of various American anti-tank/tank guns and gun motor carriages (tank destroyers).

I. Guns

37-mm. This gun was America's standard anti-tank gun at the beginning of the war and also equipped various tanks and armored cars.[1]

Weight (M3A1)	912 lb.
Projectile weight	1.92 lb.
Muzzle velocity	2,900 fps
Penetration (of homogenous armor angled at 30°:	65 mm at 0 yards 57 mm at 500 yards 50 mm at 1,000 yards 43 mm at 1,500 yards 36 mm at 2,000 yards

57-mm. This gun was an American version of the British 6-pounder anti-tank gun, and the two versions did not differ greatly.[2]

Weight (M-1A3)	3,053 lb.
Projectile weight	6 lb. 4¾ oz.
Muzzle velocity	2,800 fps
Penetration:	100 mm at 0 yards 84 mm at 500 yards 73 mm at 1,000 yards 60 mm at 1,500 yards 48 mm at 2,000 yards

75-mm. This gun was used in the M3. The towed version was not issued as an antitank weapon but the weight is listed for comparative purposes.[3]

Weight (M1897A4)	3,007 lb.
Projectile weight	14.92 lb.
Muzzle velocity	2,050 fps
Penetration:	76 mm at 0 yards
	68 mm at 500 yards
	60 mm at 1,000 yards
	52 mm at 1,500 yards
	47 mm at 2,000 yards

3-inch. This gun equipped the M10 and also existed in a towed version, the M6.[4]

Weight (M6)	5,850 lb.
Projectile weight	15.43 lb.
Muzzle velocity	2,600 fps
Penetration:	108 mm at 0 yards
	98 mm at 500 yards
	90 mm at 1,000 yards
	81 mm at 1,500 yards
	74 mm at 2,000 yards

76-mm. This gun equipped some Sherman tanks and the M18. No towed version was mass produced during World War II. Projectile weight and ballistic data are the same as the 3-inch gun.

90-mm. This gun equipped the M26 tank and M36. A towed version also existed but did not become standard equipment.[5]

Weight (T-5E2)	7,800 lb.
Projectile weight	23.56 lb.
Muzzle velocity	2,600 fps
Penetration:	123 mm at 0 yards
	113 mm at 500 yards
	104 mm at 1,000 yards
	95 mm at 1,500 yards
	87 mm at 2,000 yards

II. Tank Destroyers.

M6, 37-mm Gun Motor Carriage. This was the 37-mm gun mounted on a ¾ ton, four-wheel drive truck.[6]

Weight	3.28 tons
Speed	55 mph
Armor	.25 inch (gunshield only)
Armament	37-mm gun

M3, 75-mm Gun Motor Carriage. This was the 75-mm gun mounted in a half-track.[7]

Weight	8.92 tons
Speed	45 mph
armor	.25 inches (sides)
	.625 inches (front)
Armament	75-mm gun

The M10, 3-inch Gun Motor Carriage. This was an adaptation of the Sherman tank's chassis.[8]

Weight	33 tons
Speed	30 mph (level)
	20 mph (3% grade)
Armor	1.5 inches (hull front)
	.75–1.5 inches (hull sides)
	2.5 inches (turret front)
	1 inch (turret sides)
Armament	3-inch gun
	cal. .50 machine gun (anti-aircraft)

M18, 76-mm gun Motor Carriage. This was the carriage which the Tank Destroyer Center desired as the ideal tank destroyer.[9]

Weight	20 tons
Speed	50 mph (level)
	15 mph (10% grade)
Armor	.5 inch (hull front and sides)
	.75–1 inches (turret front)
	.5 inches (turret sides)
Armament	76-mm gun
	cal. .50 machine gun (anti-aircraft)

M36, 90-mm Gun Motor Carriage. This was the M10 modified to carry the 90-mm gun.[10]

Weight	31 tons
Speed	30 mph (level)
	10 mph (10% grade)

Armor	1.5–2 inches (hull front) .75–1.5 inches (hull sides) 3 inches (turret front) 1.25 inches (turret side)
Armament	90-mm gun cal. .50 machine gun (anti-aircraft)

III. Tanks.

M4 Medium Tank. There were many modifications to the Sherman tank, but the model number only indicated different engines as follows: Continental R-975 air-cooled radial, M4 and M4A1; twin General Motors 6-71 diesel truck engines (most of these were sent to Russia), M4A2; Ford V-8, M4A3; and Chrysler multi-bank 30 cylinder, M4A4 (used almost exclusively by the British).[11]

Weight	33 tons (M4 and M4A1), 34.5 tons (M4A2), 34 tons (M4A3), and 35.5 tons (M4A4)
Speed	24–29 mph (depending on engine)
Armor	2–3 inches (hull front depending on modifications) 1.5 inches (hull sides) 3 inches (turret front) 2 inches (turret side)
Armament	75- or 76-mm gun [tanks with the 76-mm gun were designated M4 (76-mm)] 2 cal. .30 machine guns cal. .50 machine gun (anti-aircraft)

T23 Medium Tank. The tank used an electric drive which was unsatisfactory to AGF. The T23 had a volute spring suspension, as did the Sherman, while the T23E3 had torsion bars and wider tracks.[12]

Weight	33 tons (T23) and 36 tons (T23E3)
Speed	35 mph

Armor	2.5 inches (hull front)
	2 inches (hull sides)
	3.5 inches (turret front)
	2.5 inches (turret side)
Armament	76-mm gun
	2 cal. .30 machine guns
	cal. .50 machine gun (anti-aircraft)

T25E1. The T23 modified to include a 90-mm gun, torquematic transmission, and torsion bar suspension.

Weight	35 tons
Speed	30 mph
Armor	3 inches (hull front)
	2 inches (hull sides)
	3 inches (turret front)
	2.5 inches (turret side)
Armament	90-mm gun
	2 cal. .30 machine guns
	cal. .50 machine gun (anti-aircraft)

T26 Medium Tank. The T26E1 was a more heavily armored version of the T25E1. The T26E3 included modifications made necessary by service tests and was standardized as the M26.

Weight	40.5 tons (T26E1) and 42.5 tons (m26)
Speed	25 mph
Armor	4 inches (hull front)
	2–3 inches (hull sides)
	4 inches (turret front)
	3 inches (turret side)
Armament	90-mm gun
	2 cal. .30 machine guns
	cal. .50 machine gun (anti-aircraft)

Notes

Introduction

1. *Washington Post,* 22 March 1945, p. 2. Cited by Constance McLaughlin Green, *The Ordnance Department: Planning Munitions for War* (Washington, D.C.: OCMH, 1955), p. 276.

2. Some samples of the controversy: Hanson W. Baldwin, "New German Tanks Prove Superior to Ours—Inquiry by Congress Urged," *New York Times,* 5 January 1945, p. 4; "Decision to the Tiger," *Newsweek,* 15 January 1945, p. 26; and Letter from Lt. Gen. George S. Patton, Jr. to Gen. Thomas T. Handy, 19 March 1945, cited in *Army Ordnance,* May–June, 1945, p. 428.

3. Col. Joseph M. Colby, "Contributions of Industry to Ordnance Tank-Automotive Engineering," *S.A.E. Journal,* September 1945, p. 535; and "From Designer to Fighter," *Armor,* January–February 1950, p. 14.

4. "Chronology," *History of the T20 Tank* (hereafter cited as *T20 History*), Ordnance Historical File (hereafter cited as OHF), entries for August 1942. *T20 History* is a bound collection of documents in the OHF. The Chronology is part of the *T20 History* and can best be described as an office journal of the Research and Development Division of the Ordnance Department. It is the best available source for day to day activities of research and development concerning the T20 tank series. Hereafter, references to the Chronology will be *T20 Chronology* followed by the entry date.

5. Russel F. Weigley, *History of the United States Army* (New York: Macmillan Co., 1967), pp. 472–73. The three official histories are: Green, *Planning Munitions*; Harry C. Thomson and Lida Mayo, *The Ordnance Department: Procurement and Supply* (Washington, D.C.: OCMH, 1960); and Lida Mayo, *The Ordnance Department: On Beachhead and Battlefront* (Washington, D.C.: OCMH, 1968). Of the three, Lida Mayo's *Beachhead and Battlefront* has the most complete and accurate discussion of the tank controversy.

6. U.S. War Department, FM 17–100, *The Armored Division* (Washington, D.C.: Government Printing Office, 15 January 1944), p. 68.

7. The term medium and light had a varied definition among different

armies. The American M3 light tank weighed 13 tons, while the British A13 and German Mark III medium tanks weighed only 18 and 20 tons respectively. Light tanks in the latter armies generally weighed less than 10 tons. See the technical appendix.

8. Green, *Planning Munitions*, passim.

9. There are several adequate sources for discussion of these early American tanks. The ones used were Green, *Planning Munitions*, and Peter Chamberlain and Chris Ellis, *British and American Tanks of World War II* (New York: Arco Publishing Co., 1969), pt. 2.

10. "Notes on G–3, Anti-tank Conference," 14–20 July 1941, War College, Washington, D.C., Andrew D. Bruce Papers, Archives, US Army Military History Research Collection, p. 7.

11. Memo from Maj. Gen. George A. Lynch to Asst. Chief of Staff, G–3, dtd. 3 July 1940, RG 337 (HQ, AGF), file no. 470.8 to 680.3, National Archives.

12. Blanche D. Coll, Jean E. Keith and Herbert H. Rosenthal, *The Corps of Engineers: Troops and Equipment* (Washington, D.C.: OCMH, 1965), p. 273, see also p. 337. There is no adequate biography of McNair. Other sources are: Gen. (Ret.) Jacob L. Devers, interview at Washington, D.C., 21 March 1974; Chief Warrant Officer E. J. Kahn, *McNair: Educator of an Army* (Washington, D.C.: The Infantry Journal, 1945), p. 50 (this is more eulogy than biography); Forrest C. Pogue, *George C. Marshall: Ordeal and Hope* (New York: Viking Press, 1965), pp. 82, 256. Coll comments on McNair's aloofness, but Devers disputes this.

13. Letter from McNair to Adjutant General, 29 July 1940, 2nd endorsement to memo from Lynch to G–3, RG 337 (HQ, AGF), file no. 470.8 to 680.3, National Archives.

14. McNair to Adj. Gen., 29 July 1940.

15. McNair to Adj. Gen., 29 July 1940.

16. Letter from McNair to Lt. Col. Earl W. Benson, dtd. 20 June 1940, RG 337 (HQ, AGF), file no. 470.8 to 680.3, National Archives.

17. Memo from Chief of Staff to Asst. Chief of Staff, G–3, 14 May 1941, quoted in its entirety in "History of the Tank Destroyer Center," RG 337, National Archives, pp. 6–7. This study divides in four parts covering four periods: 1 December 1941 to 15 November 1943; 16 November 1943 to 28 February 1944; 1 March 1944 to 31 October 1944; and 1 November 1944 to 8 May 1945. Hereafter it will be cited, respectively, as *TDC History I; TDC History II*, etc.

18. Capt. C. R. Kutz claims that heavy tanks made the German penetration at Sedan in "Break-Through Tanks" in *Army Ordnance*, November–December, 1940, p. 242. Maj. A. C. Wedemeyer still considered them a threat in his article "Anti-tank Defense," *The Field Artillery Journal*, XXXI, May 1941, p. 260.

Chapter 1

1. Memo from Chief of Staff to Asst. Chief of Staff, G–3, 14 May 1941, quoted in its entirety in *TDC History I*, Chap. I, pp. 6–7.

2. *TDC History I*, Chap. I, p. 8. This source does not identify the battle which must have been Gen. Sir Archibald P. Wavell's attack of 15 June 1941.

3. "Anti-tank Conference," Bruce Papers, pp. 45–46.

4. "Anti-tank Conference," Bruce Papers, pp. 7, 76–77.

5. "Anti-tank Conference," Bruce Papers, p. 82.

6. *TDC History I*, Chap. I, p. 14.

7. *TDC History I*, Chap. I, p. 15.

8. *TDC History I*, Chap. I, p. 15.

9. *TDC History I*, Chap. I, p. 15.

10. Letter from Bruce to Brig. Gen. Earnest J. Dawley, 13 June 1944, Bruce Papers.

11. Lt. Col. Emory A. Dunham, *Tank Destroyer History*, Study No. 29, Historical Section, AGF, 1946, p. 6. After March 1942 the Center received the title "Command." However, Dunham does not clarify the distinction between Command and Center; both terms were used.

12. Dunham, *Tank Destroyer History*, pp. 6–7.

13. Dunham, *Tank Destroyer History*, pp. 6–7. The purpose of the Board was to perform service tests of tank destroyer equipment. Every combat arm had its own Board.

14. Green, *Planning Munitions*, pp. 259–74.

15. Green, *Planning Munitions*, pp. 262–63.

16. Letter from Bruce to Brig. Gen. Ernest J. Dawly, 13 June 1944; letter from Bruce to Lt. Col. Thos. T. Stevenson, 27 April 1942, Bruce Papers, and "Bruce, Andrew Davis, Lt. Gen. (05257)" *Generals of the Army*, June 1953, pp. 6–8.

17. Letter from McNair to Bruce, 10 July 1942, Bruce Papers.

18. Letter from McNair to Bruce, 11 June 1943, Bruce Papers.

19. Dunham, *Tank Destroyer History*, pp. 10–11.

20. Dunham, *Tank Destroyer History*, pp. 10–11.

21. U.S. War Department, *Organization and Tactics of Tank Destroyer Units*, FM 18-5, 16 June 1942, pp. 32–48.

22. FM 18–5, 1942, pp. 48–55.

23. FM 18–5, 1942, pp. 56–67.

24. FM 18–5, 1942, pp. 65–67.

25. FM 18–5, 1942, pp. 113–22.

26. FM 18–5, 1942, pp. 7, 19.

27. FM 18–5, 1942, pp. 127–82.

28. FM 18–5, 1942, p. 7.

29. This statement needs qualification. American industry was rich enough to give the US Army the best of both worlds. Infantry divisions contained sixty organic anti-tank guns, more than the French divisions of 1940 which had only fifty at full establishment. But in 1941 the planners thought that hundreds of guns would be needed to stop a Panzer attack, so the statement is correct. For details on French organization see Maj. Robert A. Doughty, "French Anti-tank Doctrine," *Military Review*, LVI, May 1976, pp. 36–48. For American organization see Kent Roberts Greenfield, Robert R. Palmer, and Bell I. Wiley, *The Organization of Ground Combat*

Troops (Washington, D.C.: Historical Division, Department of the Army, 1947), pp. 301–302.

30. For a discussion of McNair's concept of force-pooling see Greenfield, Palmer, and Wiley, *Organization*, pp. 290–97.

31. FM 18–5, 1942, p. 8.

32. "Anti-tank Conference," Bruce Papers, p. 28.

33. Memo from Col. Orlando Ward, Secretary, General Staff, to Asst. Chief of Staff, G-3, 8 January 1941, RG 337, (HQ, AGF), file no. 470.8 to 680.3, National Archives.

34. Letter from McNair to Asst. Chief of Staff, G-3, 16 January 1941, 1st end. to memo from Ward to G-3, RG 337 (HQ, AGF), file no. 470.8 to 680.3, National Archives.

35. FM 18–5, 1942, p. iv.

36. Greenfield, Palmer, and Wiley, *Organization*, pp. 4–6, 14; and Pogue, *Marshall: Ordeal*, p. 256. As the war progressed the theaters became administrative headquarters supporting the tactical formations. For example, ETO assumed administrative functions supporting the American units in the Allied Expeditionary Force. Supreme Headquarters Allied Expeditionary Force directed combat operations and answered to the Combined (British and American) Chiefs of Staff.

37. Letter from CG, AGF to Chief of Armored Force, 2 March 1943, file no. 470.8, Records of the AGF, RG 337, National Archives. Hereafter these files will be cited as AGF followed by the file number.

38. "Biographical Data on Brig. Gen. Gladeon M. Barnes," 1946, OHF; and Green, *Planning Munitions*, pp. 220–23.

39. Green, *Planning Munitions*, pp. 223–28; and Irvin Stewart, *Organizing Scientific Research for War* (Boston: Little, Brown and Co., 1948), p. 153.

40. Green, *Planning Munitions*, p. 234.

41. James E. Hewes, *From Root to McNamara: Army Organization and Administration, 1900–1963* (Washington, D.C.: Center of Military History, US Army, 1975), pp. 120–26.

42. Pogue, *Marshall: Ordeal*, pp. 296–98.

43. G. MacLeod Ross, *The Business of Tanks, 1933 to 1945* (Elms Court, Great Britain: Arthur H. Stockwell Ltd., 1976), p. 197.

44. Hewes, *From Root to McNamara*, pp. 65–66. Hewes tells us that Maj. Gen. John K. Herr, Chief of Cavalry in 1938, went to his deathbed claiming that "the Army had betrayed the horse."

45. Greenfield, Palmer, and Wiley, *Organization*, pp. 408–10.

46. Devers interview.

47. Devers interview.

48. Greenfield, Palmer, and Wiley, *Organization*, pp. 408–410.

49. FM 17–33, Armored Force Manual, *The Armored Battalion, Light and Medium* (Washington, D.C.: Government Printing Office, 18 September 1942), p. 37.

50. Forrest C. Pogue, *George C. Marshall: Organizer of Victory* (New York: The Viking Press, 1973), pp. 136–38.

51. Maj. Gen. Gladeon M. Barnes, "Research and Development Ser-

vice," *Journal of Applied Physics,* December 1945, p. 749. Barnes implies that the OTC members exercised veto power over developments, but reviewing samples of the minutes of those meetings does not support this.

52. Green, *Planning Munitions,* p. 239.

Chapter 2

1. For a discussion of production problems see Thompson and Mayo, *Procurement,* chaps. 10 and 11.

2. Devers, interview.

3. "History of the Armored Force, Command and Center," AGF Study No. 27, Historical Section, AGF, 1943, p. 86 (hereafter cited as *Study No. 27*). The date, January 1942, is questionable. "Chronology, History of the Light Tank T7 Series," *OHF,* shows no mention of Devers asking for the 75-mm gun until 15 June 1942. This document is like the *T20 History* and will be cited the same way.

4. Chamberlain and Ellis, *British and American Tanks,* pp. 97–98.

5. Letter from Devers to CG, AGF, 5 November 1942, in G-4 Decimal File (War Department G-4), file no. 470.8, National Archives. Hereafter cited as *G-4* followed by the file no.

6. The specified weight of the M7 was twenty-five tons, but the first pilot tanks were found to be four tons overweight. This was a surprise. International Harvester began an investigation to find out if overweight castings and forgings were the culprits. See *M7 Chronology,* 10 February 1943.

7. Letter from Devers to CG, AGF, 16 March 1942, G-4 (470.8).

8. Memo from Requirements to CG, HQ, AGF, 11 March 1943, G-4 (470.8).

9. Requirements to CG, HQ, AGF, 11 March 1943. OCM item 18582, 6 August 1942, *M7 History* includes the following specifications: weight, 25 tons; height, 7 feet, 10 inches; speed, 35 mph.

10. Dr. F. M. von Senger und Etterlin, *German Tanks of World War II* trans. by J. Lucas, (New York: Galahad Books, 1967), pp. 59–62; and Heinz Guderian, *Panzer Leader* (New York: Ballantine Books, 1957), pp. 215–22.

11. New tanks could arrive speedily at the front, and existing ones could be returned to the factory for modification. The ready availability of factory technicians and spare parts helped troops to cope with the technical problems inherent in new vehicles.

12. R. P. Hunnicutt, *Pershing: A History of the Medium Tank T20* (Berkeley, Calif.: Feist Publications, 1971) p. 49.

13. *T20 Chronology,* 24 May 1942.

14. Hunnicutt, *Pershing,* p. 49.

15. Hunnicutt, *Pershing,* p. 50.

16. Hunnicutt, *Pershing,* p. 50.

17. *T20 Chronology,* 18 August 1942.

18. Telephone interview with Maj. Gen. (Ret.) Louis T. Heath, member of the Armored Board 1941–1945, on 15 September 1974.

19. *T20 Chronology,* 18 September 1942.

20. Item 20342, Ordnance Committee Minutes (hereafter cited as *OCM*), 24 April 1943, RG 156, National Archives. Item 20342 mentions item 19000 of 8 October 1942, which established the three different tanks. For a full account of all the various versions of the T20 series, see Hunnicutt, *Pershing,* p. 50 ff.

21. Torquematic was a name for a hydro-mechanical transmission that substituted a torque converter for a mechanical clutch. The term will be used throughout this study. This is basically the same "automatic" transmission that is present in many modern automobiles.

22. Torsion bars are bars that twist to provide springing action as opposed to the compression action of coil springs. They are used in many modern tanks and some automobiles; e.g., the Volkswagen "Beetle."

23. *T20 Chronology,* 16 September 1942.

24. *T20 Chronology,* 1 October 1942.

25. "Anti-tank Conference," Bruce Papers, pp. 29, 32.

26. "Anti-tank Conference," Bruce Papers, p. 28.

27. "Anti-tank Conference," Bruce Papers, p. 28.

28. *TDC History I,* Chap. VI, pp. 3–4.

29. *TDC History I,* Chap. VI, p. 3; and "Anti-tank Conference," Bruce Papers, pp. 28–29.

30. Dunham, *Tank Destroyer History,* 29, pp. 2–3; and *AT Conf.*, pp. 28–29.

31. The difficulty in developing ammunition is often underestimated by laymen. Ammunition usually proves to be the most difficult problem in gun/ammunition design.

32. *TDC History I,* Chap. VI, pp. 3–4.

33. Dunham, *Tank Destroyer History,* p. 9.

34. *TDC History I,* Chap. IV, pp. 8–9.

35. Letter from Bruce to Brig. Gen. W. B. Palmer, 26 January 1943, Bruce Papers.

36. Letter from GHQ (/s/ McNair) to the Adj. Gen., 6 January 1941, RG 337 (HQ, AGF), file no. 470.8 to 680.3, National Archives.

37. "Ordnance Annex," 18 January 1943 to *Report of the mission headed by Lieutenant General Jacob L. Devers to examine the problems of Armored Force units in the European Theater of Operations,* RG 337 (HQ, AGF), file no. 320.2/26 (Armored Command), National Archives. Hereafter cited as Devers report.

38. *TDC History I,* Chap. IV, p. 10; and memo from McNair to Chief of Staff, US Army (Attn: G-3), 5 January 1943, AGF (472).

39. Memo from Barnes to Capt. Weyher, 9 September 1940, *History of 3-Inch Gun Carriage M1, M1A1, and M6, OHF.* This document is like the *T20 History* and will be cited in the same way.

40. Item 16368, 27 December 1940, OCM.

41. *3-Inch Chronology,* 22 October 1941, 12 November 1941.

42. *3-Inch Chronology,* 28 February 1942.

43. Letter from HQ, SOS to Chief of Ordnance, 26 July 1942, 1st ind. to memo from Chief of Ordnance to CG, SOS, 17 July 1942, *3-Inch History.*

44. Memo from Chief of Ordnance to CG, SOS, 17 July 1942, *3-Inch History.*

45. Letter from HQ, SOS, to Chief of Ordnance, 26 July 1942, *3-Inch History.*

46. Mrs. Anne B. Jones, *3-Inch Gun Motor Carriages* unpublished manuscript in OHF, "3-Inch Gun Motor Carriage M5 (T1)," p. 1.

47. Jones, *3-Inch Carriages,* p. 2.

48. Item 17642, 24 November 1941 with endorsements, OCM.

49. Jones, *3-Inch Carriages,* pp. 2, 7.

50. Jones, *3-Inch Carriages,* p. 8. Jones only mentions the fact that a factory had been constructed.

51. Letter from Bruce to Col. Wendell Westover, Asst. Chief of Staff, G-2, Tank Destroyer Center, 24 November 1943, Bruce Papers.

52. Jones, *3-Inch Carriages,* pp. 7–8; and letter from McNair to Bruce, 10 July 1942, Bruce Papers.

53. Letter from HQ, AGF, to CG, SOS, 23 August 1942, *3-Inch History.*

54. Memo from HQ, AGF, to CG, SOS, 1 July 1942, AGF (472). AGF wanted to keep the 37-mm gun in infantry battalions because it was so portable, but the regimental anti-tank guns and all tank destroyer units would convert to 3-inch guns.

55. Letter from HQ, AGF, to CG, SOS, 23 August 1942, *3-Inch History.*

56. Jones, *3-Inch Carriages,* "3-Inch Gun Motor Carriages M-10, M-10A1 (T35, T35E1)," pp. 1–2.

57. "Notes Taken at Conference at Aberdeen Proving Ground, Md. on May 2, 1942," Bruce Papers, p. 1.

58. "Statement of Colonel G. M. Dean," 18 October 1945, AGF (470.8).

59. Letter from Bruce to Brig. Gen. W. B. Palmer, 26 January 1942, Bruce Papers.

60. "Notes Taken at . . . Aberdeen," Bruce Papers, p. 6.

61. "Notes Taken at . . . Aberdeen," Bruce Papers, p. 4.

62. "Notes Taken at . . . Aberdeen," Bruce Papers, p. 13.

63. Ross, *Business of Tanks,* p. 197.

64. Letter from Bruce to Westover, undated, Bruce Papers. From other documents the date of this letter can be generally established as between November 1943 to January 1944.

65. "Rough Draft, Conversation between Gen. Bruce and Gen. Devers," undated, Bruce Papers. From other documents the date of this conversation can be established as 10 December 1942.

66. Memo from RQT 1 (Moore) to McNair, 22 February 1943, *AGF (473.1).*

67. Letter from HQ, AGF, to CG, SOS, 9 October 1942, AGF (470.8).

68. Letter from Palmer to the Chief of Staff, US Army, "Subject: Final Report of Special Armored Vehicle Board," 5 December 1942, AGF (470.8).

69. *TDC History I,* Chap. VI, p. 2.

70. Palmer report.

71. *TDC History I,* Chap. VI, pp. 15–16. Volute springs are spiraled coils of steel bar which resemble a conch shell and are far more compact than coil springs which carry the same weight. Bogie wheels are the wheels on which a tank travels. They are generally smaller than the road wheels of torsion bar or Christie suspensions, but perform exactly the same function. The difference between the terms is more of usage than definition. As a rule, road wheels are independently sprung and bogie wheels are part of a system of levers that couple at least two wheels.

72. Dunham, *Tank Destroyer History,* 29, *Study No. 29,* p. 60. The Christie suspension consisted of large road wheels, independently sprung with bell-cranks and coil springs, permitting high speed. It was an invention of Walter J. Christie, a controversial figure involved in tank development during the inter-war years. The T42's suspension was a Christie-type in that it used independently sprung wheels, but it was not a true Christie suspension since it did not use bell-cranks.

73. Dunham, *Tank Destroyer History,* p. 60.

74. Memo from Barnes to Campbell, "Subject: History of Tank Guns," 1 October 1944, OHF.

75. Letter from Devers to CG, AGF, 21 November 1942, AGF (470.8).

76. *TDC History I,* Chap. VI, p. 17.

Chapter 3

1. Letter from Capt. Atlee W. Wampler, Jr., to Commanding General, Armored Force, 15 April 1943 with the following endorsements: (1) CG, II Corps directs CG, 1st Armored Division to comment, 1 May 1943; (2) Comment of CG, 1st Armored Division (Maj. Gen. Ernest H. Harmon), 2 June 1943; (3) Comment of CG, II Corps (Lt. Gen. Omar N. Bradley), 15 June 1943; (4) Comment of CG, I Armored Corps (Lt. Gen. George S. Patton, Jr.); (5) Comment of CG (Maj. Gen. C. R. Huebner), Force 141 (US Contingent); and (6) Comment of Commander in Chief, Allied Force Headquarters (Lt. Gen. Dwight D. Eisenhower) signed for the Commander in Chief by Brig. Gen. T. J. Davis, all in AGF (470.8).

2. Mayo, *Beachhead and Battlefront,* p. 149.

3. Lt. Col. Albert N. Garland and Howard McGaw Smyth, *Sicily and the Surrender of Italy* (Washington, D.C.: OCMH, 1965), pp. 163–74.

4. *History of the 67th Armored Regiment* (Brunswick, Germany: George Westermann, 1945), p. 235.

5. Letter from Lt. Col. P. W. Gillem and Maj. D. W. Hoppock to Maj. Gen. G. M. Barnes, "Interview with Capt. Perkins at Walter Reed Hospital," 20 October 1943, OHF.

6. Martin Blumenson, *Salerno to Cassino* (Washington, D.C.: OCMH, 1960), p. 73.

7. "Ordnance Annex," Devers Report, pp. 2, 26.

8. Devers Report, p. 1.

9. Testimony of Maj. Gen. Levin H. Campbell to the House Committee on Appropriations, House of Representatives, U.S. Congress, 78th Congress, 1st Session, 9 May 1943, p. 363.

10. Devers Report, pp. 1–2.

11. Final report of Maj. Allerton Cushman, 15 April 1943 Intelligence Reports, Foreign Observer Reports, Folder 48, AGF files, RG 337, National Archives, p. 19.

12. Report of Colonel Thomas J. Heavey, 19 February 1943 AGF Observer Reports, Folder 1, p. 24.

13. Heavey report, p. 23.

14. Cushman report, p. 19.

15. Heavey report, p. 23.

16. Cushman report, p. 19.

17. George F. Howe, *Northwest Africa: Seizing the Initiative in the West* (Washington, D.C.: OCMH, 1957), p. 434.

18. The entire narrative of B Company 701st Tank Destroyer Battalion is extracted from Capt. Gilbert A. Ellman, "Gafsa and Sbeitla," *TD Combat in Tunisia*, January 1944, Bruce Papers, pp. 1–16.

19. Report of Maj. Gen. C. P. Hall, 7 May 1943 AGF Observer Reports, Folder 49, p. 4.

20. For details of the action and a view of the general situation see Howe, *Northwest Africa*, pp. 557–60.

21. Lt. Col. H. D. Baker, CO, 601st Tank Destroyer Battalion, "El Guettar," *TD Combat in Tunisia*, January 1944, Bruce Papers, pp. 17–18.

22. Baker, *TD Combat in Tunisia*, pp. 17–30. There is some confusion about the battle. In *Northwest Africa* Howe claims that the 899th Tank Destroyer Battalion was involved, but Baker does not mention this. The *Cushman Report* only says that a company of the 899th was sent to help.

23. Baker, *TD Combat in Tunisia*, pp. 17–30.

24. Ladislas Farago, *Patton: Ordeal and Triumph* (New York: Dell Publishing Co., 1963), pp. 245–46.

25. Letter from Col. H. J. McChrystal to Bruce, 30 October 1943, Bruce Papers.

26. Dunham, *Tank Destroyer History*, p. 26.

27. Letter from Bruce to Maj. Gen. Orlando Ward, 1 October 1943, Bruce Papers.

28. George S. Patton, Jr., *War as I Knew It* (Boston: Houghton Mifflin Co., 1947), p. 220.

29. Greenfield, Palmer, and Wiley, *Organization*, p. 427.

30. Memo from Lucas to the Commander-in-Chief, 26 August 1943, AG 370.2, RG 407, National Archives, pp. 2–3. This report was widely distributed in AGF and usually referred to as the Seventh Army Report.

31. Memo from G-3 to CG, 15 October 1943, AGF (470.8).

32. Howe, *Northwest Africa*, pp. 514–19.

33. Cushman report, p. 14.
34. Miller report, 5 March 1943, AGF Observer Reports, Folder 17, passim.
35. Miller report.
36. "Ordnance Annex," Devers report, p. 12.
37. Letter from Col. D. J. Crawford to the Chief of Ordnance, 9 April 1943, OHF.
38. Hall Report.
39. Robert R. Palmer, *Reorganization of Ground Troops for Combat,* Study No. 8 (Historical Section, AGF, 1946), pp. 22, 32.
40. Memo from Brig. Gen. I. H. Edwards to CG, AGF, 26 January 1943, and memo from G-4 to Requirements, 5 February 1943, both in *AGF (472).*
41. Palmer, *Reorganization of Ground Troops,* p. 22.
42. Letter from McNair to Bruce, 2 January 1943, Bruce Papers.
43. Palmer, *Reorganization of Ground Troops,* p. 32.
44. Cushman report, p. 6.
45. Heavey report, p. 25.
46. Seventh Army report, p. 3.
47. Cushman report, pp. 1, 3.

Chapter 4

1. Dunham, *Tank Destroyer History,* p. 35.
2. FM 18–5, 1942, pp. 107–12; FM 18–5, 1944, pp. 72–93.
3. Letter from Bruce to McNair, 5 June 1943, Bruce Papers.
4. FM 18–5, 1944, pp. 5, 76–79.
5. FM 18–5, 1942, p. 20. Several later references are devoted to fire and movement. FM 18–5, 1944, uses the term only once, p. 59.
6. FM 18–5, 44, pp. 6, 57.
7. Dunham, *Tank Destroyer History,* p. 30.
8. Letter from HQ, AGF, to CG, Tank Destroyer Center, 22 August 1942; quoted in "Heavy Anti-tank Carriages," April 1944, OHF.
9. Letter from Bruce to CG, AGF, 9 October 1942, AGF (472.1).
10. Dunham, *Tank Destroyer History,* p. 30.
11. Dunham, *Tank Destroyer History,* p. 30.
12. *TDC History I,* Chap. I, p. 30.
13. *TDC History I,* Chap. I, p. 30.
14. *TDC History III,* Chap. II, p. 4.
15. Letter from McNair to Bruce, 11 June 1943, Bruce Papers.
16. Greenfield, Palmer, and Wiley, *Organization,* p. 427.
17. Item 17545, 7 November 1941, *OCM,* with endorsement from the War Dept., 10 December 1941, in "History of the 3-inch Gun Carriage M1, M1A1 and M6," OHF. This collection is like the *T20 History* and will be cited the same way.
18. Letter from HQ, SOS, to Chief of Ordnance, 26 July 1942, *3-inch History.*

19. Letter from HQ, AGF, to CG, SOS, 23 August 1942, *3-inch History*.

20. *3-inch Chronology*, 25 August 1942.

21. *3-inch Chronology*, 27 August 1942.

22. OCM item 22132, 18 November 1943, appended to "Heavy Anti-tank Carriages," April 1944, OHF.

23. OCM item 22132.

24. Dunham, *Tank Destroyer History*, pp. 65–67.

25. *3-inch Chronology*, 1 February 1944.

26. "Heavy Anti-tank Carriages," pp. 3–4.

27. Item 19438, 4 January 1944, OCM.

28. Letter from HQ, AGF, to CG, SOS, 6 January 1943, AGF (473).

29. Letter from Brig. Gen. J. Christmas, Tank-Auto. Center to CG, SOS, 15 February 1943, accompanied by AGF memo slip with entries Requirements to CG, 22 February 1943 and CG to Requirements, 23 February 1945, AGF (473). Parenthetically, an interesting point in Christmas' letter points out the willingness of manufacturers to engage in a little war-profiteering. The transmission manufacturer (unnamed by Christmas) demanded 176 machine tools, extremely critical items, but settled for nine after being informed that an alternate manufacturer existed.

30. Maj. D. L. McCaskey, *The Role of Army Ground Forces in the Development of Equipment*, Study No. 34, Historical Section, AGF, 1946, p. 65; and *TDC History II*, Chap. II, p. 3.

31. McCaskey, *Role of AGF in Development*, p. 65, and letter from Tank-Automotive Center to Chief of Ordnance, 7 December 1943, AGF (473).

32. Letter from Chief of Ordnance to CG, ASF, 15 February 1944, AGF (473).

33. Letter from Maj. Gen. S. G. Henry, New Developments Division, to Deputy Chief of Staff, US Army, 23 February 1944, Records of the Chief of Staff (hereafter cited as *C/S*), RG 165, file no. 470.8, National Archives.

34. The fast development of the M18 obviously wasted funds, and such profligate spending would have been unacceptable in peacetime.

35. Item 18495, 1 July 1942, OCM.

36. Moore is quoted in a letter from Col. Ray. C. Montgomery to Bruce, undated, Bruce Papers. From other information in the letter, its date was probably sometime in the period July to October 1942.

37. Letter from AGF to CG, Anti-aircraft Command, 25 July 1942 and 2nd endorsement from Anti-aircraft Bd. to CG, Anti-aircraft Command, 19 August 1942, AGF (472).

38. Item 18726, 26 August 1942, OCM.

39. Letter from McNair to Bruce, 10 July 1942, Bruce Papers.

40. Letter from HQ, AGF, to CG, TDC, 11 September 1942, AGF (472). The "Memo for record" portion of this letter, which cites a letter from Bruce, 1 September 1942, is the source of Bruce's comment.

41. Item 23745, 12 April 1944, OCM.

42. "History of the 90mm Gun (AT), T5E2," OHF, entry for 15 September 1942. This document is similar to the *T20 History* and will be cited the same way.

43. Item 20126, 22 March 1943, *OCM*.
44. *T-5 Chronology*, 29 April 1943.
45. Letter from HQ, AGF, to CG, TDC, 18 April 1943, AGF (472).
46. Letter from HQ, AGF, to CG, TDC, 18 April 1943.
47. "Activities of Maj. Gen. G. M. Barnes," 1 October 1943, OHF. This is a daily record signed by Barnes. Although the official histories refer to this as the *Barnes Diary*, it is really not a diary since it contains no personal information.
48. Letter from HQ, AGF, to CG, ASF, 2 November 1943, *AGF (473.1)*.
49. Letter from Office of the Chief of Ordnance to CG, ASF, 2nd Ind. to letter above, 8 February 1944, AGF (473.1).
50. Letter from Link-Belt Co. to Mr. G. W. Sullivan, Ordnance Department, 4 November 1943, *T-5 History*.
51. Letter from Maj. S. F. Musselman to Chicago Ordnance Office, 6 January 1944, *T-5 History*.
52. *T-5 Chronology*, 18 January 1944.
53. "Chronology," *History of the 90-mm Gun Motor Carriage, T-71 (M-36)* entry for 21 September 1942, OHF. This document is similar to the *T20 History* and will be cited the same way.
54. Item 21210, 10 July 1943, OCM.
55. *M-36 Chronology*, 10 December, and 28 December 1942.
56. Item 19845, 13 January 1943, OCM.
57. Item 19845, OCM. Memo from HQ, AGF, to the Ordnance Committee, 9 February 1943, is an appendix to this OCM item.
58. Item 22129, 8 November 1943, OCM.
59. *M-36 Chronology*, 10 May, 10 August, 23 August, and 13 September 1943.
60. *M-36 Chron.* 21 September, 22 September, and 24 September 1943.
61. Letter from Barnes to CG, ASF, 4 October 1943, *M-36 History*.
62. Memo from Requirements 1 to G-3, CG, 9 October 1943, AGF (470.8).
63. Memo from Requirements 1 to G-3, CG, 9 October 1943, and Memo from G-3 to CG, 15 October 1943, AGF (470.8).
64. Greenfield, Palmer, and Wiley, *Organization*, pp. 427–28.
65. Memo from Armored Branch, G-3 Section to G-3, 12 October 1943, AGF (470.8).
66. Memo from G-3 to CG, 15 October 1943, AGF (470.8).
67. Memo from CG to CS, 22 October 1943, AGF (470.8).
68. Letter from HQ, AGF, to CG, ASF (2nd endorsement to Barnes's letter of 4 October), 25 October 1943, AGF (470.8).
69. *M-36 Chronology*, 6 January, 17 January, 19 February, and 10 April 1944.
70. Item 24985, 29 August 1944, OCM.
71. *T20 Chronology*, 10 January, 27 February, 10 March, 15 March, and 20 March 1943.
72. Memo from Campbell to Somervell, 23 March 1943 in *T20 History*.
73. *T20 Chronology*, 5 April 1943.

74. Memo from Maj. Gen. Lucius D. Clay, Asst. Chief of Staff for Material, ASF, to Chief of Ordnance, 9 April 1943, *T20 History,* 1st endorsement of Memo from Campbell to Somervell, 23 May 1943.

75. *T20 Chronology,* 1 October 1942, 29 March 1943.

76. Item 20342, 24 April 1943, OCM, copy in *T20 History.*

77. Mayo, *Beachhead and Battlefront,* p. 25. An 88-mm gun arrived at Aberdeen Proving Ground in the late spring of 1942.

78. Item 20342, 24 April 1943, OCM, and Memo from Barnes to CG, ASF, 6 May 1943, AGF (470.8).

79. Memo from Asst. Chief of Staff, G-4 to CG, ASF, 24 May 1943, AGF (470.8).

80. Memo from Clay to Chief of Ordnance, 26 May 1943, 1st endorsement to memo Barnes to CG, ASF, 6 May 1943, AGF (470.8). The condition of the documents relating to AGF's approval of the T25 and T26 in this file is quite interesting. They are attached to a cover sheet dated 29 November 1943, from ASF to AGF which makes reference to a phone conversation of 26 November and notes that Gen. Moore initialed the correspondence of 6 May. During the disputes that followed in November, AGF apparently could not remember ever having approved the T25 and T26.

81. *T20 Chronology* Entries for 30 April, 10 May, 15 May, 22 May, and 10 July 1943.

82. Hunnicutt, *Pershing,* pp. 62, 68.

83. *T20 Chronology,* 22 July 1943.

84. Draft OCM Item, 24 July 1943, *T20 History.*

85. "For Record Only," letter from HQ, ASF, to CG, AGF, 28 July 1943, 2nd endorsement to letter from Deputy Chief of Ordnance, TAC to Chief of Ordnance, Subject: "Additional Procurement of Medium Tanks," 20 July 1943, (hereafter cited as "Additional Procurement"), Records of ASF, file no. 470.8 (hereafter cited as ASF), RG 407, National Archives. An idiosyncracy of military letters is the "For Record Only" section usually found at the bottom of a filed document. This entry is very useful and sometimes the entire history of a basic communication and its related documents can be found summarized on a single page. In this case the basic communication was not available but the "For Record Only" proved to be an adequate summary. The "For Record Only" entries can be verified by checking how different headquarters summarize a given document.

86. Letter from Ordnance Office to HQ, ASF, 24 July 1943, 1st endorsement of "Additional Procurement" and Letter from HQ, ASF to CG, AGF, 28 July 1943 (2d indorsement of "Additional Procurement"), ASF.

87. Devers interview.

88. Letter from HQ, AGF, to CG, ASF, 29 July 1943, 3rd endorsement of "Additional Procurement," ASF.

89. Letter from Clay to Chief of Ordnance, 31 July 1943, 4th endorsement of "Additional Procurement," ASF.

90. Letter from Barnes to HQ, ASF, 12 August 1943, 5th endorsement of "Additional Procurement," ASF.

91. Letter from HQ, AGF, to CG, ASF, 19 August 1943, ASF.

Chapter 5

1. *T20 Chronology,* 2 August 1943.

2. This matter is not entirely clear. In *Pershing,* Hunnicutt does not explain how the transmission problems were corrected, but the Draft OCM item of 24 July and *T20 Chronology* entry for 2 August both mention substituting the T70 transmission.

3. Mayo, *Beachhead and Battlefront,* p. 330.

4. Memo from CG, AGF, to Chief of Staff, US Army, 11 January 1943, AGF (470.8).

5. Statement of Dean, 18 October 1945, AGF (470.8).

6. Letter from CG, 1st Armored Division of CG, NATOUSA, US Army, 17 October 1943, *G-4 (470.8).* Maj. Gen. Ernest Harmon was commander of the 1st Armored Division and former member of the Armored Force.

7. The question of mechanics was particularly revealing. AGF studies indicated that only the most intelligent recruits could master the repair of electrical components, and AGF stood in line behind AAF and ASF to receive such people. See Robert R. Palmer, Bell J. Wiley, and William R. Keast, *The Procurement and Training of Ground Combat Troops* (Washington, D.C.: Historical Division, Department of the Army, 1948), pp. 2–4, 17.

8. Table "A" of letter from Holly to CG, SHAEF, 15 February 1945, Records of the Armored Fighting Vehicles and Weapons Section European Theater of Operations, (hereafter cited as *ETO*), RG 338, National Archives.

9. Letter from CG, AGF, to CG, Armored Command, 6 December 1943, AGF (470.8).

10. Chronology, *History of the M4 (76-mm gun), OHF,* 4 September 1943. This document is like the *T20 History* and will be cited the same way.

11. Letter from Gillem to CG, AGF, "Subject: Employment of Medium Tank M4, Armed with the 76-mm gun, M1," 1 September 1943, AGF (470.8).

12. "Memo for Record" on letter from HQ, AGF, to CG, ASF, 28 September 1943, 5th endorsement to "Employment of the M4," AGF (470.8); and letter from HQ, ASF to CG, AGF, 16 September 1943, 4th endorsement to "Employment of the M4," ASF.

13. "Employment of the M4," AGF (470.8).

14. Letter from HQ, AGF, to CG, ASF, 6 September 1943, 1st endorsement to "Employment of the M4" AGF (470.8); and letter from HQ, ASF, to Chief of Ordnance, 9 September 1943, 2nd to "Employment of the M4," ASF.

15. Letter from Maj. Gen. T. J. Hayes, Acting Chief of Ordnance, to HQ, ASF, 13 September 1943, 3rd endorsement to "Employment of the M4," *T20 History.*

16. Letter from HQ, ASF, to CG, AGF, 16 September 1943, 4th endorsement to "Employment of the M4," ASF.

17. Mayo, *Beachhead and Battlefront,* pp. 330, 338.

18. *T20 Chronology,* 10 September 1943.

19. Memo from Col. Walter P. Hensey, Jr., Supply Division G-4, to ACS, G-4, 21 September 1943, G-4 (470.8).

20. Maj. Irl D. Brent, III Final Historical Report (hereafter cited as *Final Report, ETO*) ETO, p. 5. The exact date of the introduction of the M-24 to combat is unclear, but Brent states that the tanks arrived shortly ahead of the training teams that arrived during March and April 1945.

21. Letter from Gillem to McNair, 4 September 1943, AGF (470.81).

22. Letter from McNair to Gillem, 5 October 1943 and attached memos from Requirements to CG, 16 September; CG to Requirements, G-3, 23 September; and C/S to CG, 1 October, in AGF (470.81).

23. *M4 (76-mm gun) Chronology,* 13 September 1943.

24. Maj. Gen. (ret.) Louis T. Heath, telephone interview on 15 September 1974.

25. R. P. Hunnicutt, *Sherman: A History of the American Medium Tank* (Belmont, California: Taurus Enterprises, 1978), pp. 212–13.

26. The weight of the T25 turret is derived from the differences in unstowed weight of the T23 (HVSS) and T25 (pilot 2) from data in Hunnicutt, *Pershing,* pp. 211–12. The tanks were identical except for the T25's larger turret.

27. *M36 Chronology,* 30 November 1943.

28. *M36 Chronology,* 10 January 1944.

29. "Technical Information Concerning American and British Tank and Anti-tank Weapons and Ammunition," an enclosure to a memo from Gen. Marshall to the President of the United States, 19 July 1944, OHF.

30. Letter from Gillem to McNair, 4 September 1943, AGF (470.81).

31. Letter from Brig. Gen. John W. Coffey, Ordnance officer of SOS, NATO, to Col. James L. Guion, Office of the Chief of Ordnance, 21 August 1944, OHF.

32. Item 26320, 8 January 1945, OCM, states that guns were designed to penetrate plates of Class "A" (face-hardened) armor angled at 20 degrees. Heavy German tanks had homogeneous armor.

33. For an easily understood explanation of guns and the penetration of armor see R. M. Ogorkiewicz, *The Design and Development of Fighting Vehicles* (London: MacDonald, 1965), pp. 55–66, 81–84. The conclusion about the Ordnance Department's technique is derived from deduction since no document revealed this conclusively. Maj. Gen. William F. Dean, AGF Requirements section, tabulated characteristics of the Panther in a memo to McNair, 18 November 1943, AGF (470.8). He gave the thickness of the glacis plate as 3 and 5/16 inches angled at 57 degrees. (Later sources agree that the true figures were 3.2 inches and 55 degrees.) A diagram entitled "Penetration of U.S. Projectiles against German Pz. Kw. V "Panther" Tank and self-propelled mount 'Ferdinand' – 0° obliquity homogeneous plate," 1 January 1945, prepared by the Ballistic Section, Technical Division, Service Branch, and approved by the Chief of Ordnance, in *ETO,* gives the effective thickness of the Panther's plate as 6 inches. A nearly identical thickness is derived from Dean's data and the following trigonometry:

$$\text{horizontal thickness} = \frac{\text{thickness}}{\text{Sin (90–56) degrees}} = 6.07 \text{ inches}$$

34. Memo from Dean, Requirements, to CG, 18 November 1943, AGF (470.8).
35. *T20 Chronology,* 4 September 1943.
36. *T20 Chronology,* 17 October 1943.
37. Memo from Brig. Gen. J. E. Hull, Acting ACS (Asst. Chief of Staff), to ACS, G-4, 18 November 1943, G-4 (470.8).
38. Memo from Hull to ACS, G-4, 18 November 1943.
39. Letter from HQ, NATO, to CG, ASF, 14 November 1943, G-4 (470.8).
40. Letter from CG, 2nd Armored Division, to Ordnance Representative, Allied Force Headquarters, 26 October 1943 with six enclosures, G-4 (470.8).
41. Letter from CG, 1st Armored Division, to CG, NATOUSA, US Army, 17 October 1943, with nine attachments, G-4 (470.8).
42. Cable from Devers to War Department, 13 November 1943, G-4 (470.8).
43. Memo from Requirements, 19 November 1943, AGF (470.8).
44. Memo from CG to Requirements, 19 November 1943, AGF (470.8).
45. Memo from CG, AGF, to Chief of Staff, US Army, "Subject: Theater Requirements for New Type Tanks," 28 November 1943, AGF (470.8).
46. Memo from CG, AGF, to Chief of Staff, US Army, "Subject: Heavier Armament for Tanks and Self-Propelled Vehicles," 30 November 1943, AGF (470.8).
47. "Heavier Armament for Tanks," AGF (470.8).
48. Letter from HQ, ASF, to ACS, G-4, 2 December 1943, G-4 (470.8). The M4 (105-mm) refers to a version of the Sherman tank armed with a light 105-mm howitzer which should not be confused with the 105-mm anti-aircraft gun.
49. Cable from McNarney to Devers, 7 December 1943, G-4 (470.8).
50. Letter from HQ, ASF, to Chief of Ordnance, Technical Division, 26 November 1943, 1st endorsement to memo from Maxwell to CG, ASF, 1943, "Subject: Theater Requirements for New Type Tanks," 22 November 1943 G-4 (470.8). The "Theater Requirements" memo was sent to both ASF and AGF.
51. Letter from Barnes to HQ, ASF, 9 December 1943, 2nd endorsement to "Theater Requirements," G-4 (470.8).
52. Memo from HQ, ASF, to Chief of Ordnance, 9 December 1943 G-4 (470.8); and letter from HQ, ASF, to ACS, G-4, 15 December 1943, 2nd endorsement to "Theater Requirements," ASF.
53. Cable from Devers to War Department, 10 December 1943, G-4 (470.8).
54. Memo from Maxwell to CG, ASF, 16 December 1943, G-4 (470.8).
55. Cable from Marshall to Devers, 21 December 1943, G-4 (470.8).
56. Memo from Clay to ACS, G-4, 30 December 1943, G-4 (470.8).
57. Memo from Maxwell to CG, ASF, 1 January 1944, G-4 (470.8).
58. Cable from Marshall to Eisenhower, 15 January 1944, G-4 (470.8).
59. Memo from Reid and Preston, British Representatives, Interna-

tional Supply Committee, to Director, International Aid Division, U.S. War Department, 25 January 1944, G-4 (470.8).

60. Cable from Marshall to Devers, 16 December 1943, ETO.

Chapter 6

1. Martin Blumenson, *Salerno to Cassino* (Washington, D.C.: OCMH, 1969), pp. 420–24.

2. Letter from Devers to Campbell, 28 May 1944, OHF.

3. For details about the Panther and German tank development see Walter J. Speilberger and Uwe Feist, *Panther* (Buena Park, Calif.: Feist Publications, 1968); Senger und Etterlin, *Tanks*; and Green, *Planning Munitions*, passim.

4. Green, *Planning Munitions*, p. 286.

5. Memo from Capt. I. D. Brent, III, to Executive Officer, AFV&W Section, "Report on Comparative Firing Program Witnessed at Shoeburyness, Essex, 23 May 1944," 24 May 1944, ETO.

6. Diagram entitled "Penetration of U.S. Projectiles against German Pz. Kw. V 'Panther' Tank and self-propelled mount 'Ferdinand'—0° obliquity homogenous plate," 1 January 1944; and diagram entitled "Penetration of U.S. Projectiles against German Pz. Kw. IV 'Special' and Pz. Kw. VI 'Tiger' Tanks—0° obliquity homogenous plate," 1 January 1944, both in ETO. These are technical diagrams prepared by Ballistic Section, Technical Division, Service Branch and approved by the Chief of Ordnance.

7. Capt. I. D. Brent III, Conference Notes, "Distribution of Medium Tank, M4 Series (76-mm gun)," 20 April 1944, ETO.

8. Message from Eisenhower to War Department, 18 May 1944, G-4 (470.8).

9. Memo from Holly to G-3, ETO, 2 May 1944, ETO.

10. Cable from Eisenhower to War Department, 20 May 1944, AGF.

11. Memo from Maj. Gen. S. G. Henry, Director, New Developments Division, to Chief of Staff, US Army, 17 April 1944, C/S.

12. Memo from Henry to Chief of Staff, 17 April 1944.

13. Brent, *Final Report, ETO*, Appendix G.

14. The General Board, United States Forces, ETO, "Report on Study of Organization, Equipment, and Tactical Employment of Tank Destroyer Units," Study No. 60, 22 April 1946, Command and General Staff College Library No. R-12885.60–2, p. 1.

15. General Board, Study No. 60.

16. General Board, Study No. 60.

17. General Board, Study No. 60.

18. Committee 24, Officers Advanced Course, The Armored School, *Employment of Four Tank Destroyer Battalions in the ETO* (Fort Knox, Kentucky, May 1950), pp. 83–84.

19. F. W. Winterbotham, *The Ultra Secret* (New York: Harper & Row, 1974), pp. 148–54.

20. *Employment of Four Tank Destroyer Battalions*, p. 85.

21. After Action Report, 823d Tank Destroyer Battalion, RG 407, National Archives, 5 and 6 August 1944 (hereafter cited as 823rd AAR).

22. *Employment of Four Tank Destroyer Battalions*, pp. 86–88; and AAR 823rd, 7 August 1944.

23. *Employment of Four Tank Destroyer Battalions*, pp. 95–96.

24. *Employment of Four Tank Destroyer Battalions*, p. 96.

25. Robert L. Hewitt, *Workhorse of the Western Front: The Story of the 30th Infantry Division*, p. 54 quoted in *Employment of Four Tank Destroyer Battalions*, p. 99.

26. 823rd, AAR 7 August 1944.

27. 823rd, AAR 7 August 1944.

28. General Board, Study No. 60, p. 10.

29. General Board, Study No. 60, p. 2.

30. Interview with Col. Richard K. Lamison (formerly in 37th Tank Battalion, 4th Armored Division 1944–45), Fort Knox, Kentucky, 12 February 1972.

31. First US Army, "Report of Proceedings of Board of Officers," *Report of Operations 1 August 1944–22 February 1945*, Annex 5, Appendix 2, pp. 65–66.

32. Brent, *Final Report, ETO*, pp. 14–15.

33. Letter from Lt. Col. W. E. Showalter, C.O. 703rd Tank Destroyer Bn, to CG, First US Army, 15 December 1944, ETO.

34. Eisenhower quoted by Omar N. Bradley, *A Soldier's Story* (New York: Popular Library, 1964; first edition 1951), p. 322.

35. *The Papers of Dwight D. Eisenhower*, 4 vols. Alfred D. Chandler, Jr., gen. ed., (Baltimore: Johns Hopkins Press, 1970), Vol. 3: *The War Years*, pp. 1973–74.

36. Bradley, *Soldier's Story*, p. 322.

37. Brent, *Final Report, ETO*, pp. 21, 24–25.

38. *A History of the 44th Royal Tank Regiment in the War of 1939–45* (London, 1965), p. 144.

39. *Twenty-third Hussars* (April 1946) quoted by Spielberger and Feist, *Panther*, p. 52.

40. Ross, *Business of Tanks*, p. 332.

41. Sabot ammunition consists of a small, hard tungsten carbide core encased in an aluminum body that separates from the core after leaving the gun's muzzle. This type of ammunition became the most important anti-tank round in American tanks during the 1980s.

42. "Final Report on board of officers appointed to determine comparative effectiveness of ammunition of 76-mm gun and 17-pounder gun," HQ, Twelfth Army Group, 30 August 1944, ETO.

43. Brent, *Final Report, ETO*, p. 20.

44. Items 26318 and 26320, 8 January 1945, OCM; and *Armor-Piercing Ammunition for Gun, 90-mm, M3* (Washington, D.C.: Office of the Chief of Ordnance, January 1945). *Armor-Piercing Ammunition* is one of a series of pocket-size manuals, nicknamed Kangaroos, which the Ordnance Depart-

ment produced to inform troops in the field about new or developmental equipment. This one is particularly interesting for two reasons. First, the Ordnance Department had clearly learned a lesson about evaluating its equipment, because the data in the manual is based on tests against German tanks. The results provided illustrations for the manual. Second, the complexity of penetrating armor is vividly demonstrated by the data. The HVAP round (T30) could penetrate thicker armor than the T33 but could not penetrate the Panther's sloped glacis plate.

45. R. P. Hunnicutt, *Sherman: A History of the American Medium Tank* (Belmont, Calif.: Taurus Enterprises, 1978), 564–65, 567.

46. Brent, *Final Report, ETO,* Appendix G.

47. H. M. Cole, *The Lorraine Campaign* (Wash., D.C.: Historical Division, Department of the Army, 1950), pp. 199, 224, and Lamison.

48. *Voo Doo: History of the 81st Tank Battalion* (81st Tank Battalion Association, 1947), pp. 36–37.

49. *Employment of Four Tank Destroyer Battalions,* p. 65; and Report No. 1095, "M-18 Hellcat Tank Destroyer," 9 February 1945, Bruce Papers.

50. *Employment of Four Tank Destroyer Battalions,* pp. 66–70.

51. *Employment of Four Tank Destroyer Battalions,* pp. 71–76.

52. *Employment of Four Tank Destroyer Battalions,* pp. 79.

53. Tables 3 and 4 compiled from information in General Burkhardt Mueller-Hillebrand's, *Tank Losses,* Project #47, Historical Division, European Command, 10 November 1950.

54. The Germans lost 77 percent of their planned production of Tiger II's due to bombing raids on the Henschel plant, sole producer of that tank. See "Henschel & Sohn, Kassel, Germany," *The United States Strategic Bombing Survey* (Washington, January 1947), p. 2.

55. First US Army, *Report of Operations,* Annex 9, p. 28.

56. Mayo, *Beachhead and Battlefront,* pp. 325–26.

57. General Board, Study No. 60, p. 18.

58. Letter from Maj. Gen. J. E. Hull, Asst. C/S to HQ, ETO, 16 November 1944, and Memo from Hull to G-4, 27 November 1944 with Memo for record, Records of the Operations and Plans Division (OPD), RG 165, file no. 472.1, National Archives.

59. Letter from HQ, AGF, to CG's Replacement and School Command, Armored Center, and Tank Destroyer Center, sometime after August 1944, Folder 189, AGF Observation Reports. The letter contains extracts of a report by Col. Clyde E. Steele who commanded a regiment of the 36th Infantry Division in France.

60. Winterbotham, *The Ultra Secret,* p. 177.

61. Hugh M. Cole, *The Ardennes: Battle of the Bulge* (Washington, D.C.: OCMH, 1965), p. 653.

62. First US Army, *Report of Operations,* Annex 4, p. 22.

63. 823rd AAR 4 December, 10 December, 11 December, 17 December, and 19 December 1944.

64. Letter from Holly to Brig. Gen. W. A. Borden, New Developments Division, War Department, 29 December 1944, G-4 (473), RG 165, National Archives.

65. *GB 60,* p. 2.

66. Routing Slip, 3 March 1945, G-4 (473), refers to the message.

67. Third Army After Action Report, Part 24, "Tank Destroyer," Chapter 13, 1 August 1944 to 9 May 1945, Command and General Staff College Library No. N-11480-B.

68. Letter from HQ, 12th Army Group, to CG, ETO, 9 November 1944, AGF (473).

69. John Toland, *Battle: The Story of the Bulge* (New York: Random House, 1959), p. 135. According to Hunnicutt, *Sherman,* p. 317, the German tanks were actually Panthers.

70. Brent, *Final Report, ETO,* Appendix G.

71. Table compiled from Brent, *Final Report, ETO,* Appendix G.

72. Cole, *Ardennes,* p. 125.

Chapter 7

1. *T20 Chronology,* 10 December 1943.

2. Hunnicutt, *Pershing,* p. 51.

3. Letter from HQ, ASF, to Chief of Ordnance, 31 January 1944, 1st endorsement to Letter from Chief of Ordnance to HQ, ASF, 19 January 1944, ASF.

4. Memo from Clay to Chief of Ordnance, 8 January 1944, ASF.

5. *T20 Chronology,* 16 March 1944.

6. Memo from HQ, ASF, to ACS, 21 February 1944, ASF.

7. Memorandum from Col. Crawford F. Sams to the Assistant Chief of Staff, G-4 War Department, "Subject: Conference on Heavily Armored Tank," 29 February 1944, AGF (470.8). Gen. Dean of AGF chaired the conference which was also attended by representatives of ASF, the Ordnance Department, and the War Department. The memorandum reveals that the decision to increase the armor of the Sherman was more rational than the one to increase the armor of the T25. AGF wanted armor thick enough to resist Germany's 88-mm Flak 41, but the eleven inches required were impractical. The conferees also consulted an operational analysis of hits made by German anti-tank guns on a Sherman and a British Churchill tank. It is not clear how the analysis affected their decision.

8. McCaskey, *Role of AGF in Development,* pp. 43–44.

9. Cole, *Lorraine,* p. 363.

10. Cole, *Ardennes,* pp. 525, 652.

11. McCaskey, *Role of AGF in Development,* p. 44.

12. *T20 Chronology,* 29 March 1944.

13. Memo from Campbell to CG, ASF, "Subject: Medium Tank T25E1 and Heavy Tank T26E1," 31 March 1944, G-4 (470.8).

14. Letter from Clay to CG, AGF, 2 April 1944, 1st endorsement to Campbell, "T25E1 and T26E1," ASF.

15. Letter from Col. Frank R. Williams, President, Armored Board, to CG, AGF, "Subject: Tank Program for 1945," 2 April 1944, ETO.

16. Letter from HQ, AGF, to CG, ASF, 12 April 1944, 2nd endorsement to Campbell, "T25E1 and T26E1," G-4 (470.8).

17. Williams, "Tank Program"; and *T20 Chronology*, 10 March and 15 March 1944.

18. Williams, "Tank Program."

19. T. R. Fehrenbach, *This Kind of War* (New York: Pocket Books, 1963), p. 719.

20. Dean, statement.

21. The General Board, US Forces, ETO, "Tank Gunnery," Study No. 53, 1945, p. 27. Copy obtained from the Office of the Chief of Military History, Department of the Army, Washington, D.C.

22. Dean, statement.

23. Memo from HQ, AGF, to Chief of Staff, US Army, 12 April 1944, G-4 (470.8).

24. Letter from HQ, ASF to ACS, G-4, 15 April 1944, 3rd endorsement to Campbell, "T25E1 and T26E1," G-4 (470.8).

25. Memo from Maxwell to CG, ASF, 17 April 1944, G-4 (470.8).

26. Dean, statement.

27. Letter from Col. J. W. Boone, Deputy Director, International Division, to Brigadier L. R. S. Dawes, 23 March 1944, G-4 (470.8).

28. Memo from Clay to ACS, G-4, 24 April 1944, ASF.

29. "For Record Only," letter from HQ, ASF, to Chief of Ordnance, Technical Division, 9 May 1944, 2d endorsement to letter from HQ, Armored Center, to AGF, 17 April 1944; and letter from Barnes to CG, ASF, 16 May 1944, 3d endorsement to Armored Center letter, ASF.

30. Memo from Maj. K. G. Peters to Asst. Chief of Staff, G-4, "Subject: Travel Report," 10 May 1944, G-4 (470.8).

31. Letter from HQ, ASF, to Chief of Ordnance, 29 April 1944, ASF.

32. Memo from Barnes to CG, ASF, 1 May 1944, ASF.

33. *T20 Chronology*, 10 May 1944.

34. "For Record Only," letter from HQ, ASF, to Chief of Ordnance, Technical Division, 2 June 1944, 2nd endorsement to letter from President, Armored Board, to CG, AGF, 20 May 1944, ASF.

35. Disposition Form signed by Maxwell, 10 June 1944; and memo from Clay to ACS, G-4, 9 June 1944, ASF.

36. Ibid.

37. Coll, Keith, and Rosenthal, *Troops*, p. 483.

38. Item 20342, 24 April 1943, OCM.

39. Col. Joseph M. Colby, "From Designer to Fighter," *Armor*, January-February 1950, p. 15.

40. Letter from Brig. Gen. B. C. Dunn, Chief Engineer, SHAEF, to Chief Engineers of 21st Army Group, 12th Army Group and 6th Army Group, 2 February 1945, *ETO*.

41. Hunnicutt, *Pershing*, p. 12.

42. OCM item 24277, 29 June 1944, copy in *T20 Hist.*

43. Chamberlain and Elles, *British and American Tanks*, p. 155.

44. Memo from CG, AGF, to CG, ASF, 3 January 1945, AGF (470.8).

45. Letter from President, Armored Board, to CG, AGF, 12 August 1944, ETO.

46. Letter from HQ, AGF, to CG, ASF, 9 July 1944; letter from HQ, ASF, to Chief of Ordnance, 18 October 1944, ASF.

47. *T-5 Chronology,* 19 February, 4 April, and 17 May 1944; letter from Ordnance Research Center to ASF, Ordnance Office, 10 May 1944, *T-5 History.*

48. Letter from Ordnance Research Center to ASF, Ordnance Office, 8 May 1944, *T-5 History.*

49. Letter from HQ, AGF, to CG, ASF, 15 May 1944, *T-5 History.*

50. *T-5 Chronology,* 2 June 1944.

51. "Memo for record," appended to letter from HQ, AGF, to CG, ASF, 14 July 1944, AGF (473).

52. Letter from HQ, AGF, to CG, ASF, 2 August 1944, with enclosure "Deficiencies, 90-mm Gun Carriage T-5E1 as developed during tests at Aberdeen Proving Ground, 20 July 1944," AGF (473).

53. Record of telephone call from Mr. Martin, Link-Belt Co., to Gen. Wells, Ordnance Department, 25 July 1944, *T-5 History;* and 31 October 1944, *T-5 Chronology.*

54. *T20 Chronology* shows frequent references to Barnes's participation, as does the "Activities of Maj. Gen. G. M. Barnes," OHF. The latter source is nearly devoid of references to the T5, as is *T5 History.* Maj. S. F. Mussleman seems to have been in charge of the T5.

55. Letter from Barnes to Devers, 31 January 1944, *T20 History.*

56. Cable from Devers to Campbell, 17 February 1944, copy in *T20 History.*

57. Cable from Campbell to Devers, 6 March 1944, G-4 (470.8).

58. Memo from Campbell to CG, ASF, 13 March 1944, *T20 History.*

59. Memo from HQ, AGF, to CG, ASF, 14 March 1944, *T20 History.*

60. McCaskey, *Role of AGF in Development,* pp. 14–15.

61. Letter from Somervell to Chief of Ordnance, 31 March 1944, *T20 History.*

62. Cable from Devers to War Department, 18 May 1944, G-4 (470.8).

63. Memo from Henry to Chief of Staff, US Army, 13 April 1944, with hand-written notation initialed "GCM", C/S.

64. Memo from Henry to Chief of Staff, US Army, 17 April 1944, *C/S.*

65. Memo from Henry to Chief of Staff, US Army, 23 April 1944, with handwritten "OK" initialed "GCM", *C/S.*

66. Cable from Marshall to Devers, 27 May 1944, G-4 (470.8).

67. Memo from Maxwell to CG, ASF, and CG, AGF, 10 June 1944, G-4 (470.8).

68. Memo from Maxwell to CG, ASF, and CG, AGF, 5 July 1944, G-4 (470.8).

69. Letter from Maj. Gen. Handy, Operations Division, General Staff, to CG, ASF and CG, AGF, 31 July 1944, G-4 (470.8).

70. Letter from Maxwell to CG, ASF, and CG, AGF, 18 August 1944, G-4 (470.8).

71. Letter from HQ, AGF, to President, Armored Board, 9 August 1944; and 1st endorsement from President, Armored Board, to CG, AGF, 15 August 1944, AGF (470.8).

72. *T20 Chronology,* 31 August 1944.

73. Letter from HQ, AGF, to CG, ASF, 6 December 1944, 6th endorsement to Letter from HQ, AGF, to CG, Armored Center, "Subject:

Development of an Improved Medium Tank" (hereafter cited as "Improved Tank"), 28 September 1944, AGF (470.8).

74. Letter from Research and Development Service, Ordnance Department, to CG, ASF, 8th endorsement to "Improved Tank," 28 February 1945.

75. Colby quoted in Green, *Planning Munitions*, p. 237.

76. "Memo for Record," 1 May 1945, AGF (470.8). The memo summarizes a meeting between the commanders of AGF, ASF, Ordnance, and other representatives held on 30 April 1945, in which AGF complained about Ordnance's refusal to conduct the design study.

77. Letter from Ordnance Department to ASF, 28 February 1945.

78. Specifications of the proposed tank are enclosed with a letter from HQ, AGF, to CG, ASF, 8 December 1944, 6th endorsement to "Improved Tank," AGF (470.8).

79. Letter from HQ, AGF, to CG, ASF, 19 October 1944, and 3d endorsement from Office of Chief of Ordnance to HQ, ASF, 27 January 1945, ASF.

80. *T20 Chronology*, 8 December 1944; and memo from Col. Howard Bruce, Acting Director of Material, to Gen. Styer, 19 December 1944, ASF.

81. Memo from HQ, ASF, to Chief of Ordnance, 22 December 1944, ASF.

82. Memo from Bruce to Styer, 19 December 1944, ASF.

83. Letter from Barnes to Campbell, "Subject: Report of Heavy Tank Mission," 6 March 1945 (hereafter cited as "Tank Mission"), ETO.

84. McCaskey, *Role of AGF in Development*, p. 45.

85. Letter from Holly to Deputy Theater Commander, "Subject: Comments on 'Report of Heavy Tank Mission' (Lt. Gen. Barnes—Gen. Campbell)," 26 March 1945, ETO.

86. Brent, *Final Report, ETO*, p. 22.

87. Letter from Holly to CG, SHAEF, "Subject: Advisability of Introducing Medium Tank, T23, Into the European Theater of Operations," 15 February 1945, ETO; and letter from Barnes to CG, ASF, 19 December 1944, 2d endorsement to letter from HQ, AGF to CG, ASF, 22 November 1944, ASF.

88. Memo from HQ, ASF, to Chief of Ordnance, 4 January 1945, *ASF*.

89. Letter from SHAEF to CG, ETO, dtd. 17 February 1945, ETO.

90. Hunnicutt, *Pershing*, p. 17.

91. Brent, *Final Report, ETO*, p. 22.

92. Hunnicutt, *Pershing*, p. 28.

93. "Tank Mission."

94. General Board, Study No. 60, p. 29.

95. Mayo, *Beachhead and Battlefront*, pp. 337–38.

Appendix 1

1. Information in this explanation was compiled from Chamberlain

and Elles, *British and American Tanks,* passim, and Senger and Etterlin, *German Tanks,* passim.

Appendix 2

1. Peter Chamberlain and Terry Gander, *Anti-tank Weapons: WW 2 Fact Files* (New York: Arco, 1974), p. 47; and table appended to "Agenda, Tank and Tank Destroyer Conference, Army War College," 26 January 1945, *AGF (470.8),* hereafter cited as *Data.* The table of ballistic performance notes is based on Enclosure 1, Military Attache Report No. 2473–44. The data is from firing tests in Great Britain and penetrations are based on 50 percent success against homogenous armor. In addition, the table contains the precaution that, due to variables in quality of plates, production shot, and errors in range estimation, the perforation thicknesses should not be interpreted as being exact.

2. *Data;* and Office of the Chief of Ordnance, Technical Division, *Catalogue of Standard Ordnance Items,* Vol. II: *Artillery and Aircraft Armament,* 1 October 1944, p. 167. *Data* lists six different rounds for the British 6-pounder but none for the American 57-mm although their ammunition was apparently interchangeable. *Ordnance Catalogue II* states that the muzzle velocity of the 57-mm gun was 2,700 fps and penetration of homogenous armor angled at 20° was as follows: 3.4 inches at 500 yards, 2.7 inches at 1,000 yards, 1.9 inches at 1,500 yards.

3. *Data;* and *Ordnance Catalogue II,* p. 158. The penetration data mentions the 75-mm tank gun. The reader is asked to accept the resulting small error in penetration, as it would apply to the M1897A4 gun (MV-2,000 fps), in order to be able to compare penetration data from a single source.

4. *Data;* and *Ordnance Catalogue II,* p. 169.

5. *Data;* and E. D. Stahr, ed., *Artillery,* an unpublished manuscript in OHF, National Archives. The muzzle velocity listed is from *Data* but some sources give the muzzle velocity as 2,650 fps.

6. Peter Chamberlain and Terry Gander, *Self-Propelled Anti-tank and Anti-aircraft Guns: WW 2 Fact Files* (New York: Arco, 1975), p. 50.

7. Chamberlain and Gandner, *Self-Propelled Guns,* p. 51.

8. Office of the Chief of Ordnance, Technical Division, *Catalogue of Standard Ordnance Items,* Vol. I: *Tank and Automotive,* 1 December 1944, p. 42.

9. *Ordnance Catalogue I,* p. 49.

10. *Ordnance Catalogue I,* p. 51.

11. Data from Chamberlain and Elles, *British and American Tanks,* pp. 115–16.

12. All data on T20 series from Hunnicutt, *Pershing,* pp. 208, 210, 213, 215, and 217.

Sources

I. Essay on Sources

This short essay is intended to help researchers. It will attempt to do two things: identify the most useful sources and specify which ones are most easily available for general research.

Magazines and newspapers do not provide very much information on the development of tanks and tank destroyers. Old technology is of little interest to most readers of periodicals, and practically all of the information on development was classified until after the war. Caution is always in order while consulting newspapers for technical information; correspondents and columnists often make errors in this area. Of course, the controversy within the US Army hardly ever appeared in print because soldiers of that day loathed washing their dirty linen in public. The best guide to technical information is the *Industrial Arts Index* (now *Applied Science and Technology*). *Air University Index* is good on all military topics, but starts in 1947. Most of the articles found by using these guides to periodicals only provided background for the organization of US Army research and development. If the guides to periodicals prove fruitless, one can always consult *Armor* (formerly the *Cavalry Journal*), the most consistent source for tank development.

Most of the men involved in development did not become famous and information on them is scarce. *Who Was Who in American History: The Military* is a convenient and valuable reference for background on these individuals.

The official histories remain the best and most complete sources for tank development which are easily available. Constance McLaughlin Green's *Planning the Munitions of War* (full citations follow) is good for general background on development, but Lida Mayo's *From Beachhead to Battlefront* is more complete and objective

on the controversy. Her footnotes provided a starting point for this author's research. To balance the official histories, one can consult G. MacLeod Ross's memoir, *The Business of Tanks*. Maj. D. L. McCaskey's *The Role of Army Ground Forces in the Development of Equipment* should be available through inter-library loan from most US Army libraries, such as the Command and General Staff College Library at Fort Leavenworth, Kansas. Another AGF study *History of the Armored Force, Command and Center,* is useful for both the history of the Armored Force and the role of that organization in developing equipment.

Information on tank destroyers is much harder to find. Brief discussions by Kent Greenfield, Robert Palmer, and Bell I. Wiley in *The Organization of Ground Combat Troops* are the only sources that one might find in most libraries. The best single source is Lt. Col. Emory A. Dunham's *Tank Destroyer History,* which is another of AGF study. After that, one must travel to Carlisle, Pennsylvania, to consult Andrew D. Bruce's papers. This collection contains letters and documents of a military nature for the period from 1941 to 1945. It is invaluable for Bruce's disputes with the Ordnance Department, and offers many insights into the Tank Destroyer Command's first two years. Operational history of the tank destroyers can be pieced together from the US Army series on World War II, e.g., H. M. Cole's *The Ardennes.* Committee 24's *Employment of Four Tank Destroyer Battalions in ETO* supplements the official histories.

Most of the information on the development of tanks and tank destroyers rests in the National Archives. The records are filed according to the *War Department Decimal filing System* which is published as a book and usually available at libraries which serve as federal repositories. The appropriate file number for any military topic can be extracted from this little volume if one cannot visit the Archives and must correspond for information.

The records of AGF, ASF, the War Department's G-4, and the Ordnance Department, all in the National Archives, were the most useful sources. However, they are difficult to use because no single agency kept a complete file of all basic letters with all of their endorsements. Often, the files of an agency contain only the endorsement of that agency, which usually makes little sense by itself. The files of all the agencies involved sometimes have to be consulted to piece together the chain of endorsements. In some cases an endorsement, or even the basic letter, cannot be found. The "memo for

record" annotation on some letters will partially compensate for this. The G-4 files offer the best chance to find a complete record including a basic letter with all of the following endorsements. AGF records are the worst with regard to this.

The records of AGF do contain informal, inter-office memos which give valuable insight into the thinking behind decisions. This information is often absent in the formal letters that resulted. The "Foreign Observer Reports" of AGF's G–2 are chronologically arranged, and an index accompanies the files. Fortunately, AGF records on tanks (470.8), guns (472), and gun carriages (473) survived the transfer to the National Archives without dispersal. Use of the file numbers yields virtually all AGF correspondence on the topics mentioned. The official histories and AGF studies also reflect the file numbers in their footnotes, and this provides ready access to AGF records on a wide variety of subjects.

ASF records are not so easily used. Correspondence on a particular topic is scattered about the Records of the Adjutant General's Office (RG 407). Aid from the archivists is mandatory, and, fortunately, they have some research aids. The effort is worthwhile since the endorsements in ASF files almost always have an excellent "memo for record" annotation.

The records of the Ordnance Department are the best single source but *must* be supplemented by the records of the other agencies mentioned. An index entitled "Research and Development" is an excellent research aid, but it is available only at the Archives. The Ordnance Department collected documents into easily used sources such as the *History of the T20 Tank* which has a chronology, best described as an office journal, followed by a selection of Ordnance Committee Items and letters related to the vehicle which, however, are incomplete, thus forcing the researcher to look into AGF, ASF, or G-4 records. In addition to documents, Ordnance records contain several historical monographs. The "Minutes of the Ordnance Technical Committee" are a valuable source but have only a chronological index. The easiest way to use the minutes is to work backwards. Find the last item (the title of the individual document) concerning a specific piece of equipment. That item will have references to all previous items that pertain to that piece of equipment. The Ordnance Committee Minutes primarily reflect decisions; they rarely reveal any controversy or provide sufficient background when used alone.

In summation, there is very little information readily available in libraries. However, the official histories are a good starting place for research.

II. Documents

Bruce, Papers of Andrew D. Archives, US Army Military History Research Collection, Army War College, Carlisle Barracks, Pennsylvania.

First US Army. Report of Operations, 1 August 1944—22 February 1945. Has important data and contains a report of the firing tests of July 1944.

Fonda, Lt. Col. Garret. Memorandum to Colonel Sims, 19 September 1945. Box P. 50009, Records of Fort Knox, RB 338. National Archives, Suitland, Maryland. Refers to Gillem's proposal to build a Sherman with the 90-mm gun.

The General Board, US Forces, ETO. *Report on Study of Organization, Equipment, and Tactical Employment of Tank Destroyer Units,* Study Number 60. 22 April 1946. Based largely on interviews and the experience of the officers on the board, this is an excellent summary of tank destroyer operations in ETO.

———. *Tank Gunnery.* Study Number 53. 1945. Has some comments on the views of tank crewmen concerning tank guns.

Office of the Chief of Ordance, Technical Division. *Catalogue of Standard Ordnance Items.* Washington, D.C., 1945. Data on American weapons.

Third US Army. *After Action Report,* 1 August 1944–9 May 1945. Has a section about tank destroyers.

U.S. Congress. *Military Establishment Appropriation Bill for 1944.* Hearings before a subcommittee of the Committee on Appropriations, House of Representatives, 78th Congress. 1st Session, 1943. The Chief of Ordnance's brief testimony before Congress.

U.S. War Department. *After Action Reports, 823d Tank Destroyer Battalion.* Record Group 407. National Archives, Suitland, M.D.

———. Records of AGF, Record Group 337, National Archives, Washington, D.C.

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